Pharmocology Research in India: A Scientometric Analysis of Publications Output, 2003–12

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ABSTRACT

The study analyses the performance of Indian pharmacological research during the last ten years (2003–12) using publications data covered in Scopus database, based on several parameters including global publication share and rank of 15 most productive countries, India's publication growth rate and citations impact, its pattern of citations output,international collaboration profile, institutional profile, geographical distribution of output, contribution and impact of top institutions and authors, pattern of communications and characterstics of high cited papers.

Keywords: Pharmacology, Scientometrics, Research output, India

INTRODUCTION

The pharmaceutical industry is growing in the entire world and is regarded as one of the most profitable industry. The pharmacy profession has evolved over the past in response to the growth in medication use and patients' demand. Today, pharmacy profession is considered as one of the most preferable and respectable profession. Pharmacy has changed and continues to change even as health care delivery systems change. around us. Pharmacy is the science concerned with therapeutic substances – their discovery, origin and nature, their development into medicines and their use in disease prevention and treatment. Pharmacy also denotes the profession which uses its unique knowledge of medicines in the service of society. The present pharmacists' role and responsibility does not lie merely in dispensing of medication but in the provision of patient focus care such as providing drug information and drug therapy recommendation i.e. pharmacists' are also the primary health professionals. Those invoved in pharmacologyresearch are concerned with synthesis of new drugs (what is commonly referred as molecules), new processes, clinical testing of the effects of such drugs on animals and humans and obtaining the required lincense from drug control authorities.[1]

In India, formal pharmacy education leading to a degree began with the introduction of a 3-year bachelor of pharmacy (BPharm) at Banaras Hindu University in 1937. Before India gained independence in 1947, there were 3 institutions offering pharmacy degree programs. In 1944, the Punjab University started a pharmacy department; in 1947 L.M. College was established in Ahmedabad. At independence in 1947, India inherited a system for the pharmacy profession from the British rulers that

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was unorganized and there was no legal restriction on the practice of pharmacy. The concept of pharmacy practice was not realized until after independence was gained. In 1948, the Pharmacy Act[5] was enacted as the nation's first minimum standard of educational qualification for pharmacy practice to regulate the practice, education, and profession of pharmacy. Currently, one needs at least a diploma in pharmacy to practice as a pharmacist. Provisions of the Act are implemented through the Pharmacy Council of India (PCI).[6] The Act requires individual states to establish state pharmacy councils that are responsible for controlling and registering pharmacists in their respective states. A variety of pharmacy degree programs are offered in India at present. Diploma in Pharmacy (D. Pharm, 2 years course) is the minimum qualification required to be a registered pharmacist in India. B. Pharm (4 years course) is offered in various universities. Some Universities also offer Pharm.D (6 years course). The first batch of Pharm.D students will graduate by 2011. Pharmacy Council of India permitted few universities to start Pharm.D (post baccalaureate) (2 years + 1 full working year internship in a 300 bedded hospital) for B pharmacy graduates. To practice as a pharmacist in India, one needs at least a Diploma in Pharmacy (DPharm), which is awarded after only 2 years and 3 months of pharmacy studies. These diploma-trained pharmacists are the mainstay of pharmacy practice. A variety of pharmacy degree programs are offered in India: Diploma in Pharmacy (DPharm), Bachelor of Pharmacy (BPharm), Master of Pharmacy (MPharm), Master of Science in Pharmacy [MS(Pharm)] and Master of Technology in Pharmacy [MTech (Pharm)], Doctor of Pharmacy (PharmD), and Doctor of Philosophy in Pharmacy (Ph. D). The entry point, for DPharm, BPharm, and PharmD programs is 12 years of formal education in the sciences.[2] By 2011–12, 1162 institutions are offering pharmacy educational programs, of which 845 offer B.Pharm programmes and191 offer Masters and Ph. D prgrammes, leading to the annual output of 51716 graduate students and 5648 postgraduate and Ph. D students.[3]

The growth of pharmacology research was rapid after 1950 in India with the opening of new medical colleges and developing postgraduate facilities at several centres, followed in due course with new institutions in pharmacy & veterinary medicine and further aided further by opening of new national laboratories such Central Drug Research Institute at Lucknow and industrial research centres of CIBA, Hoechst, Ranbaxy, Dr Reddy's, etc. The growth was substantially helped later with the return of many pharmacologists trained abroad, provision of fellowship by agencies like Rockfeller Foundation and WHO for training abroad and within the country, and establishment of specialized units and centres of advanced research by ICMR, CSIR, DBT, DST, etc.The Drugs & Pharmaceuticals Research Programme (DPRP) was initiated by DST in 1994-95 for promoting industry-institutional collaboration in drugs & pharmaceutical sector which aimed at enhancing capabilities of R&D institutions and industrialin units towards development of new drugs. Presently, apart from strengthening intellectual property protection system, government is providing soft loans, grants and tax benefits to promote R&D activities. Public-Private Partnerships (PPPs) initiated by DST and CSIR are providing avenues for risk sharing and better collaboration between public research facilities and private sector for development of NCEs. Presently most of the pharmaceutical R&D is carried out by private sector companies, with major R&D spenders like Dr. Reddy's laboratories, Glenmark and Piramal enterprises spending 7–8% of total income in 2013 in R&D. The Department of Pharmaceuticals in the Ministry of Chemicals & Ferlizers was created on 1.7.2008for coordination of activities in the pharmacy profession at the national level, including R&D activities.[4]

The Indian pharmaceutical sector has come a long way, being almost non-existent before 1970 to a prominent provider of healthcare products, meeting almost 90% of the country's pharmaceuticals needs for bulk drugs, drug intermediates and formulations. The annual turnover of the Indian pharmaceutical industry is estimated to have increased from 61219 crores to 104209 crores from 2006 to 2010. Globally, the Indian pharmaceutical industry ranks 4th in terms of volume (8% market share) and 13th in terms of value (with share of 1% in global sales). Large, medium & small pharma players totaling about 24000 manufacturing units are in India employing about 1.5 million people.Indian pharma companies produce about 20–22% of the world's generic drugs (in terms of value).

Literature Review

A few evaluative studies have been carried out in the past on contribution of impact of pharmacological research measured in terms of publications output on global scale[5,6], regional level[7,8] , as well as on specific countries such as India[9], China[10], Saudi Arabia[11] and Spain.[12] The present study makes an extensive evalution of pharmacological research in India for last ten years (2003–12), using Scopus database

Objectives

The main objectives of this study are to analyze the research performance of India in pharmacologicalresearch during 2003–12, based on publications output, as

covered and indexed in Scopus database. In particular, the study focuses on the following objectives:

to study the global contribution, share and rank of top 15 most productive countries in pharmacology;

(i) To study the growth, citation impact anof international collaboration of Indian publications in pharmacology;

(ii) To study the patterns of citation distribution and characterstics of India's high cited papers;

(iii) To study the the trends in pharmacological research in India, using significant keywors;

(iv) To study the geographical distribution of Indian pharmacological research papers;

(v) To study the contribution and impact of different types of Indian organications;

(vi) To study the contribution and impact of top 30 Indian institutions and authors inpharmacology; and

(vii) To study and identify the the major Indian and foreign journals contributing to Indian pharmacological research.

Methdology

The study is based on publication data on pharmacological research retrieved from Scopus database (http://www.scopus.com) for 10 years from 2003 to 2012. The study identified publications in pharmacology, using Scopus database classification of subjects. First India is searched in "Affiliation" field during the period tag "2003–2012" and the output was further limited to "pharmacology" subject tag. This become our main string for searching data on India and 14 other most productive countries. For generating citation impact data, the three years, two years, one year citation window was used for publications during 2003-10, 2011 and 2012. For searching the international collaborative papers, the main search strategy was restricted to further "country" tag for identifying India's collaborating countries and significant collaborating partners. For analyzing institutional, author and journals output, the separate search strategies were developed which later combined with the main search string to generate the desired output.

ANALYSIS

Global Contribution of Top 15 Most productive Countries

The global publication share of top 15 most productive countries in pharmacological research varied from 1.44% to 25.04% during 2003–12. The United States tops the list with global publication share of 25.04% (1st rank), followed far behind by China (9.51% share and second rank), India (7.52% share and third rank), Japan, U.K., Germany, Italy and France (their global publication share ranging from 4.32% to 7.39% and rank from 4th to 8th), Canada, Spain, South Korea and Brazil (their global publication share ranging from 2.17% to 2.46% and rank from 9th to 12th) and Australia, Netherlands and Switzerland (their global publica-

Table 1. Publication Output, Share and Rank of Top 15 Countries in Pharmacological Research, 2003–12

S.No	Country Name	Number of Papers			% Share of Papers			Publication Rank		
		2003–07	2008–12	2003–12	2003–07	2008–12	2003–12	2003–07	2008–12	2003–12
1	USA	78306	96935	175241	25.82	24.4	25.04	1	1	1
2	China	18994	47562	66556	6.263	12	9.51	4	2	2
3	India	13162	39483	52645	4.34	9.95	7.52	6	3	3
4	Japan	23469	23876	47345	7.738	6.02	6.76	2	5	4
5	UK	21006	24592	45598	6.926	6.2	6.51	3	4	5
6	Germany	18420	20594	39014	6.073	5.19	5.57	5	6	6
7	Italy	11932	15615	27547	3.934	3.94	3.94	7	7	7
8	France	11612	13032	24644	3.829	3.29	3.52	8	8	8
9	Canada	9556	10648	20204	3.151	2.68	2.89	9	10	9
10	Spain	9458	10359	19817	3.118	2.61	2.83	10	11	10
11	South Korea	6775	11547	18322	2.234	2.91	2.62	11	9	11
12	Brazil	5439	9747	15186	1.793	2.46	2.17	14	12	12
13	Australia	5962	7417	13379	1.966	1.87	1.91	13	13	13
14	Netherlands	6173	6720	12893	2.035	1.69	1.84	12	14	14
15	Switzerland	4155	5915	10070	1.37	1.49	1.44	15	15	15
	World	303288	396623	699911	100	100				

tion share ranging from 1.49% to 1.87% and rank from 13th to 15th) during 2003–12 (Table 1).

Among the top 15 most productive countries, (i) the publication share has increased in China by 5.74% (from 6.26% to 12.00%), India by 5.61% (from 4.34% to 9.95%), South Korea by 0.68% (from 2.23%% to 2.91%), Brazil by 0.67% (from 1.79% to 2.46%) and Switzerland by 0.12% (from 1.37% to 1.49%) in contrast to decrease in case of Japan by 1.72% (from 7.74% to 6.02%), USA by 1.42% (from 25.82% to 24.40%), Germany by 0.88% (from 6.07% to 5.19%), UK by 0.73% (from 6.93% to 6.20%), France by 0.54% (from 3.83% to 3.29%), Spain by 0.51% (from 3.12% to 2.61%), Canada by 0.47% (from 3.15% to 2.68%), Netherlands by 0.34% (from 2.03% to 1.69%) and Australia by 0.10% (from 1.97% to 1.87%) from 2003-07 to 2008–12

Among the top 15 most productive countries, the publication rank has increased in India (from 6th to 3th), China (from 4th to 2th), South Korea (from 11th to 9th) and Brazil (from 14th to 12th) as against decrease inJapan. (from 2th to 5th), UK (from 3th to 4th), Germany (from 5th to 6th), Canada (from 9th to 10th), Spain (from 10th to 11th) and Netherlands (from 12th to 14th) from 2003–07 to 2008–12. During the same period, the publication rank has remained the same in Italy, France, Australia and Switzerland (Table 1)

India's Contribution Growth and Citation Impact

The world output in pharmacology research consisted of 699911 papers and has increased from 55604 papers in 2003 to 86782 papers in 2012, witnessing an annual average growth rate of 5.16%. Indian contribution in pharmacologicalresearch consisted of 52645 papers and has increased from 2016 papers in 2003 to 10684 papers in 2012, witnessing an annual average growth rate of 21.13%. The cumulative growth of world output in pharmacological research has increased from 303288 papers during 2003-07 to 396623 papers during 2008–12, experiencing a growth rate of 30.77%. Compared to this, Indian cumulative growth of Indian research output in pharmacological research has increased from 13162 papers during 2003–07 to 39483 papers during 2008-12, experiencing a growth rate of 199.98%. The average citation impact per paper registered by India's pharmacological research was 2.87 during 2003-12 (Table 2).

Of the total Indian research output during 2003–12, 46045 papers are published as articles, 4112 as reviews, 981 as letters, 600 as conference papers,and rest as editorials, short surveys, note, etc. English language contributed 46045 papers to Indian research output during 2003–12, followed by remaining output in 11 other languages..

Pattern of Citation Distribution of Indian Output

Of the total Indian pharmacological output, 47.97% papers received no or zero citations, in contrast to 52.03% papers receiving citations from 1 to 705 during 2003-2012 since their publication till the end of 20113. Of the total cited papers, 29.77% (25254 papers) received from 1-9 citations, 11.53% (6070 papers)

Table 2. Annula Growth in World & Indian Contribution and International Collaborative Papers in Pharmacology, 2003–12

Publication Period	Number of Papers		Number of ICP	
	World	India	No. of Papers	% Share of Papers
2003	55604	2016	219	10.9
2004	58575	2214	241	10.9
2005	61087	2465	286	11.6
2006	62713	3088	283	9.16
2007	65309	3359	312	9.29
2008	70486	4135	407	9.84
2009	72061	5813	518	8.91
2010	78316	8160	663	8.13
2011	88976	10691	792	7.41
2012	86782	10684	861	8.06
2003–07	303288	13162	1341	10.2
2008–12	396623	39483	3241	8.21
2003–12	699911	52645	4582	8.70

ICP=International Collaborative Papers

Table 3. Patterns of Citations received by Indian Pharmacology Papers, 2003–12

Citation Range	Number of Papers	% Share of Papers
>100	227	0.43
75–99	205	0.39
50–74	711	1.35
40–49	629	1.19
30–39	1173	2.23
20–29	2599	4.94
10-19	6070	11.53
1–9	15777	29.77
Zero	25254	47.97
	52645	

from 10-19 citations, 4.94% (2599 papers) from 20-29 citations, 2.23% (1173 papers) from 30-39 citations, 1.19% (629 papers) from 40-49 citations, 1.35% (711 papers) from 50-74 citations, 0.39% (205 papers) from 75–99 citations and 0.43% (227 papers) 100 and above citations during 2003–12 (Table 3).

High Cited Papers

Of the 227 high cited papers, 192 papers received citations from 100 to 195, 22 papers from 201 to 287 citations, 8 papers from 304 to 385 citations, 3 papers from 400 to 499 citations, 1 paper each 504 and 705 citations since their publication up to December 2013. Of the 227 high cited papers, 128 are published as articles, 91 as reviews, 5 as conference paper and 3 as short surveys. Out of 227 high cited papers published by Indian scientists in pharmacology, 40 papers involve international collaboration and 48 national collaborations. Among the high cited papers, the largest contribution comes from National Institute of Pharmaceutical Education & Research, Mohali (22 papers), Panjab University, Chandigarh (11 papers), Jadavpur University, Kolkata (11 papers), DrHarisingh Gour University, Sagar (10 papers), University of Delhi (7 papers), Jamia Hamdard, Delhi (7 papers), Indian Institute of Chemical Technology, Hyderabad (7 papers), Central Drug Research Institute, Lucknow (6 papers), National Chemical Laboratory, Pune (6 papers), Indian Institute of Toxicological Research, Lucknow (4 papers), Bhabha Atomic Research Center, Mumbai (4 papers), All India Institute of Medical Sciences, New Delhi (4 papers), Institute of Technology, Banaras Hindu University, Varanasi (4 papers), Birla Institute of Technology & Science, Pilani (3 papers), Annamalai University (3 papers), Indian Association for Cultivation of Science, Kolkata 93 papers), Centre for Cellular & Molecular Biology, Hyderabad (3 papers), et al.

These 227 high cited papers were published in 32 journals, including 22 papers in *Tetrahedron Letters*, followed by *Journal of Controlled Release* (21 papers), *Journal of Ethnopharmacology* (19 papers), *Tetrahedron* (14 papers), *International Journal of Pharmaceutics* (12 papers), *European Journal of Medicinal Chemistry* (11 papers), *Bioorganic & Medicinal Chemistry* (8 papers), *Bioorganic & Medicinal Chemistry Letters* (6 papers), *Toxicology* (6 papers), *Life Sciences* (5 papers), *Current Medicinal Chemistry* (5 papers), *Biochemical Pharmacology* (4 papers), *Pharmacological Research* (4 papers), *Toxicology Letters* (4 papers), *Advanced Drug Delivery* Review (4 papers), *Medicinal Research Reviews* (4 papers), *Nanomed Nanotech Biology & Medicine* (4 papers), *European Journal of Pharmaceutical Science* (3 papers), *European Journal of Pharmaceutics & Biopharmaceutics* (3 papers),*Phtotherapy Research* (3 papers), *Biological & Pharmaceutical Bulletin* (3 papers), *Food & Chemical Toxicology* (3 papers), *Phytomedicine* (3 papers), *Drug Discovery Today* (3 papers), *Free Radical Biology & Medicine* (2 papers), *Neuropharmacology* (2 papers), *AAPS PharmSciTech* (2 papers), *QSAR & Combinatorial Science* (2 papers), *Phytochemistry* (2 papers), *British Journal of Pharmacology* (2 papers), *Drug Development & Industrial Pharmacy* (2 papers), *Chemico-Biological Interactions* (2 papers), and 37 other journals with 1 paper each..Some of the prominent authors involved in high cited papers include PK Mukherjee (6 papers), RK Khar (5 papers), NK Jain (5 papers), SK Jain (5 papers), VR Sinha (4 papers),JS Yadav (3 papers), R Panchagnula (3 papers), R. Jain (3 papers), R. Kumaria (3 papers), K. Mukherjee (3 papers), FJ Ahmad (2 papers), J Ali (2 papers), AK Bansal (2 papers), K Roy (2 papers), Alka Ahuja (2 papers), PT Perumal (2 papers), S Talegaonkar (2 papers), S Jain (2 papers), K Kaur (2 papers), R Jain (2 papers), Y Sultana (2 papers), A. Singla (2 papers), R. Kaushik (2 papers), K Bansal (2 papers), S. Dhawan (2 papers), et al . A list of top 25 high cited papers is given in (Table 4).

Geographical Distribution of Indian Pharmacological Output

Nearly all Indian geographical regions are partcipitating in Indian pharmacological research output during 2003-12. The largest contribution to Indian pharmacological output comes from Maharashtra with 13.46% share, followed by Andhra Andhra Pradesh (11.79% share), Tamil Nadu (10.49% share), Karnataka (10.21% share), Uttar Pradesh (10.21% share), Delhi (7.58% share), Gujarat, Madhya Pradesh, Rajasthan and Panjab (between 3.75% to 5.96% share), Chandiagarh (2.40% share), Kerala (2.09%) and other states less than 1% share dur-

Table 4. List of Top 25 Highly Cited Papers by Indian Scientists in Pharmacology, 2003–12

S.No	Name of Authors	Affiliation	Source	# of Citations
1	S.A.Agnihotri, NN Mallikarjuna & T.M.Aminabhavi	Karnataka University, Dharwad	Journal of Controlled Release 2004, 100(1), 5-25	705
2	N, Jain, A. Kumar et al	Univ of Delhi	Tetrahedron 2005, 61(5), 1055–1060	541
3	RK Maheshwari, RK Singh, J. Gaddipati, RC Srimal	Industrial Toxicological Research Center, Lucknow	Life Sciences 2005. 61(5), 1055–60	457
4	M. George and TE Abraham	Regional Research Laboratory, Trivandrum	Journal of Controlled Release 2006, 1114(1), 1–14	451
5	VR Sinha, AK Singla et al	Panjab University, Chandigarh	International Journal of Pharmaceutics 2004, 274(1-2), 1–33	419
6	I Rahman, SK Biswas and PA Kirkham	Univ of Rochester Medical Center, USA and Dr Ambedkar College, Nagpur	Biochemical Pharmacology 2006, 72(11), 1439–52	385
7	VR Sinha and A Trehan	Panjab University, Chandigarh	Journal of Controlled Release 2003, 90(3), 261–280	384
8	MK Chourasia and SK Jain	Dr Harisingh Gour University, Sagar	Journal of Pharmacology & Pharmaceutical Science 2003, 6(1), 33–66	373
9	VR Sinha, K Bansal et al	Panjab University, Chandigarh	International Journal of Pharmaceutics 2004, 278(1), 1-23	363
10	V Singh and S Batra	Central Drug Research Institute, Lucknow	Tetrahedron 2008, 64(20) 4511–4574	340
11	RC Mundargi, VR Babu et al	Reliance Life Sciences Ltd. Mumbai	Journal of Controlled Release 2008, 125(3), 193–209	335
12	I Rahman, SK Biswas and A Kode	Univ of Rochester Medical Center, USA and Dr Ambedkar College, Nagpur	European Journal of Pharmacology 2006, 533(1-3), 222–239	305
13	R Challa, A Ahuja et al	Jamia Hamdard, Delhi	AAPS PharmSciTech 2005, 6(2), E329–357	304
14	PP Roy and K Roy	Jadavpur University, Kolkata	QSAR & Combinatorial Science 2008, 27(3), 302–313	287
15	K Srinivasan, B Viswanad et al	National Institute of Pharmaceutical Education & Research, Mohali	Pharmaceutical Research 2005, 52(4), 313–20	272
16	P Anand, SG Thomas et al	University of Kerala & Indian Institute of Information Technology, Allahabad	Biochemical Pharmacology 2008, 76(11), 1590–1611	267
17	BP Bandgar and KA Shaikh	Swami Ramanand Teerth Marathwada University, Aurangabad	Tetrahedron Letters 2003, 44(9), 1959–1961	264
18	M Vaswani, FK Linda and S Ramesh	All India Institute of Medical Sciences, New Delhi	Progress in Neuro-Psychopharmacology & Biological Psychiatry 2003, 27(1), 85–102	263
19	I Bala, S Hariharan & MNVR Kumar	National Institute of Pharmaceutical Education & Research, Mohali	Critical Review in Therapeutic Drug Cancer Systems 2004, 21(5), 387–422	255
20	D Bhadra, S Bhadra et al	Dr Harisingh Gour University, Sagar	International Journal of Pharmaceutics 2003, 257(1-2), 111–124	244
21	DV Ratnam, DD Ankolaet al	National Institute of Pharmaceutical Education & Research, Mohali	Journal of Controlled Release 2006, 113(3), 199–207	236
22	AS Paraskar, GK Dewkar and A Sudalai	National Chemical Laboratory, Pune	Tetrahedron Letters 2003, 44(16), 3305–3308	232
23	A Kar, BK Choudhary & NG Bandyopadhyay	Satsang Herbal Research Laboratory, Deoghar	Journal of Ethnopharmacology 2003, 84(1), 105–108	231
24	VB Patravale, AA Date & RM Kulkarni	Mumbai University Institute of Chemical Technology, Mumbai	Journal of Pharmacy & Pharmacology 2004, 56(7), 827–840	230
25	JK Vasir, K Tambwekar & S.Garg	National Institute of Pharmaceutical Education & Research, Mohali	International Journal of Pharmaceutics 2003, 255(1–2), 13–32	225

ing 2003–12. The Maharashtra, Andhra Pradesh, Tamil Nadu, Karnataka and Uttar Pradesh together contributed 56.27% share of the Indian pharmacological output during 2003–12.The publication share has increased in Rajasthan by 2.04%, followed by Gujarat (1.60%), Tamil Nadu (1.54%), Andhra Pradesh (1.24%), Karnataka (1.04%), Himachal Pradesh (0.82%), Uttarakhand (0.58%), Chhatisgarh (0.57%), Bihar (0.56%), Madhya Pradesh (0.52%), Haryana (0.36%), Jharkhand (0.35%), J&K (0.33%) and NE States (0.25%) as against decrease in Delhi by 3.50%, followed by Panjab (1.97%), Chandigarh (1.72%), Uttar Pradesh (0.83%), Kerala (0.46%), Pandicherry and Goa (0.09% each) from 2003-07 to 2008-12. In terms of citation impact per paper, the highest (3.83) was achieved by Panjab, followed by Chandigarh (3.80), Delhi (3.56), NE States (3.41), Uttar Pradesh (3.39), Andhra Pradesh (3.26), Kerala (3.15), Madhya Pradesh (3.04), Goa (2.82), Tamil Nadu (2.77), Haryana (2.72), Maharashtra (2.66), J&K (2.65), Karnataka (2.40), Gujarat (2.24), Pondicherry (2.20), Jharkhand (2.19), Himachal Pradesh (2.03), Rajasthan (1.84), Uttrakhand (1.70), Bihar (1.65) and Chhatisgarh (1.63) during 2003-12.(Table 5)

International Collaboration

Theshare of international collaborative research papers in total Indian research output in pharmacology was 8.70% during 2003–13, which decreased from 10.20% during 2003–07 to 8.21% during 2008-12 (Table 2). Among the foreign countries collaborating with India in pharmacological research during 2003-12, the largest share (38.21%) has been contributed by USA, followed by UK (8.97% share), Germany (6.26%), Saudi Arabia (5.15%), Malaysia (5.15%), South Korea (4.98%), Japan

Table 5: Geographical Distribution of Indian Pharmacological Output, 2003–12

S.No	Name of State	Number of Papers			% of Papers			TC	ACPP
		2003–07	2008–12	2003–12	2003–07	2008–12	2003–12	2003–12	2003–12
1	Maharashtra	1722	5364	7086	13.08	13.6	13.46	18856	2.66
2	Andhra Pradesh	1430	4775	6205	10.86	12.1	11.79	20247	3.26
3	Tamil Nadu	1232	4290	5522	9.36	10.9	10.49	15298	2.77
4	Karnataka	1259	4174	5433	9.56	10.6	10.32	13023	2.40
5	Uttar Pradesh	1425	3949	5374	10.83	10	10.21	18241	3.39
6	Delhi	1343	2647	3990	10.2	6.7	7.58	14211	3.56
7	Gujarat	626	2513	3139	4.76	6.36	5.96	7048	2.24
8	Madhya Pradesh	483	1664	2147	3.67	4.21	4.08	6524	3.04
9	Rajasthan	335	1809	2144	2.54	4.58	4.07	3951	1.84
10	Panjab	689	1288	1977	5.23	3.26	3.75	7568	3.83
11	Chandigarh	486	777	1263	3.69	1.97	2.40	4799	3.80
12	Kerala	321	782	1103	2.44	1.98	2.09	3480	3.15
13	Haryana	322	1108	1430	2.45	2.81	2.72	3884	2.72
14	J&K	146	567	713	1.11	1.44	1.35	1893	2.65
15	NE States (7)	164	594	758	1.25	1.5	1.44	2581	3.41
16	Himachal Pradesh	35	429	464	0.27	1.09	0.88	942	2.03
17	Chhatisgarh	50	374	424	0.38	0.95	0.80	690	1.63
18	Uttarakhand	39	346	396	0.30	0.88	0.75	672	1.70
19	Pondicherry	96	253	349	0.73	0.64	0.66	769	2.20
20	Bihar	13	261	274	0.10	0.66	0.52	452	1.65
21	Jharkhand	45	271	316	0.34	0.69	0.6	691	2.19
22	Goa	42	89	131	0.32	0.23	0.25	369	2.82
		13162	39483	52645					

TC=Total Citations; ACPP=Average Citation Per Paper

(4.56%), France (3,95%), Canada (3.40%), Australia (3.27%), Belgium (3.23%), Italy (3.08%), Switzerland (2.36%) and China (2.33%).The share of international collaborative papers has increased by 5.91% (from0.97 to 6.88%) in Saudi Arabia, 5.17% (from 1.49% to 6.66%) in Malaysia, 4.29% (from 1.94% to 6.23%) in South Korea, 1.78% (from 2.01% to 3.79%) in Australia, 1.12% (from 1.56% to 2.68%) in Switzerland, 0.35% (from 2.98% to 3.33%) and 0.07% (from 3.36% to 3.42%) in Canada as against decrease by 8.2% (from 44.07% to 35.79%) in USA, 3.9% (from 4.02% to 5.12%) in Germany, 3.7% (from 7.16% to 3.49%), 2.6% (from 10.81% to 8.21%) in UK and 1.4% (from 4.92% to 3.55%) in France from 2003-07 to 2008-12 (Table 6).

Some of most productive collaborating foreign organizations with Indian organizations in Indian pharmacological research are shown in following (Table 7). The strongest collaboration is observed between University of Reading, UKand Indian Association for Cultivation of Science, Kolkata (15 papers), King Saud University, Saudi Arabia and Indian Institute of Chemical Biology, Kolkata (13 papers), followed byNational Institute of Health, Bethesda, USA and Birla Institute of Technology and Science, Pilani (12 papers), University of Strathclyde, UKand Panjab University, Chandigarh (10 papers), Kitasato University, Japan and Bose Institute, Kolkata (9 papers), Kitasato University, Japan and Tripura University (9 papers), Regional Institute of Medical Research, Belgium and MD University, Rohtak (9 papers), University of Reading, UK and Dr Harisingh Gour University, Sagar (9 papers), National Institute of Health, Bethesda, USA and Dr Harisingh Gour University, Sagar (8 papers), Universita degli studi di Firenze, Italy and APS University, Rewa (8 papers), etc

Keyword Subject Analysis

On analyzing the focus of pharmacological research by different type of drug activities, the largest output came from drug synthesis (with 6553 papers), followed by drug structure (5514 papers), drug screening (5099 papers), drug formulation (4730 papers), drug effect (4225 papers), drug efficacy (3987 papers), drug delivery system (3516 papers), drug solubility (3160 papers), drug mechanism (3095 papers), drug stability (2647 papers), drug isolation (2370 papers), drug bioavailability (1793 papers), drug dose response relationship (1760 papers), drug safety (1723 papers), drug potency (1649 papers0, drug design (1464 papers), drug absorption (1348 papers), drug half life (973 papers), drug delivery system (969 papers), etc during 2003-12

On analyzing the focus of pharmacological research by different parts of body, the largest output came from organ liver (with 4233 papers), followed by heart (2162 papers), brain (1986 papers), stomach (1870 papers), kidney (1829 papers), lung (1428 papers), muscle (1300 papers), intenstine (897 papers), breast (811 papers), eye

Table 6. Number and Share of International Collaborative Papers in Indian Pharmacology Output, 2003–12

Collaborative country	Number if International Collaborative papers			Share of international collaborative papers		
	2003–07	2008–12	2003–12	2003–07	2008–12	2003–12
USA	591	1160	1751	44.07	35.79	38.21
UK	145	266	411	10.81	8.207	8.97
Germany	121	166	287	9.023	5.122	6.26
Saudi Arabia	13	223	236	0.969	6.881	5.15
Malaysia	20	216	236	1.491	6.665	5.15
South Korea	26	202	228	1.939	6.233	4.98
Japan	96	113	209	7.159	3.487	4.56
France	66	115	181	4.922	3.548	3.95
Canada	45	111	156	3.356	3.425	3.40
Australia	27	123	150	2.013	3.795	3.27
Belgium	40	108	148	2.983	3.332	3.23
Italy	45	96	141	3.356	2.962	3.08
Switzerland	21	87	108	1.566	2.684	2.36
China	33	74	107	2.461	2.283	2.33
	1341	3241	4582			

Table 7. Leading Most Productive Foreign Organisations along with Indian Parners in Indian Pharmacological Research, 2003–12

	Foreign Collaborating Organizations	# of Papers	Indian Collaborating Partners
1	Regional Institute of Medical Research, Belgium	65	MD Univ., Rohtak (9), BITS-Pilani (6), Arulmigu Kalasalingam Coll Pharmacy (7), GJ Univ of Science & Technology-Hisar (6)
2	King Saud University College of Science, Saudi Arabia	54	IITR-Luck (7), AMU-Aligarh (7), Jamia Millia Islamia (5), IICB-Kolkata (5), Jamia Hamdard (4)
3	King Saud University, Saudi Arabia	52	IICB-Kolkata (13), IITR-Luck (6), Jamia Hamdard (5), A,U-Aligarh (5), Annamalai Univ (4)
4	King Saud University College of Pharmacy, Saudi Arabia	46	Jamia Hamdard (7), Utkal Univ (5)
5	Univ of Mississippi, USA	42	BITS-Pilani (7), Univ of Delhi (7), Jamia Hamdard (3)
6	Universiti Sains Malaysia	39	Alwar Pharmacy Coll (7), NIT-Karnataka (5), Bengal Engn & Sci Univ (4)
7	International Medical University, Malaysia	39	Jadav Univ (5), Arulmigu Kalasalingam Coll Pharmacy (4), JN Tech Univ (4)
8	National Institute of Health, Bethesda, USA	36	BITS-Pilani (12), Dr Harisingh Gaur Univ (8), IT-BHU (3)
9	University of Bradford, UK	35	Bharati Vidyapeeth Univ-Pune (24), IITR-Luck (5)
10	National University of Singapore	35	Univ Mysore (6)
11	University of Queensland, Australia	30	Manipal Coll Pharm (7), Dr Harisingh Gaur Univ (6)
12	Organisation Mondiale de la sante, Switzerland	28	Jamia Hamdard (6), IMS-BHU (4)
13	University of Reading, UK	27	IACS-Kolkata (15), Dr Harisingh Gaur Univ (9), Univ Calcutta (6),
14	Asian Institute of Medicine Science & Technology, Malaysia	27	Guru Ghasidas Univ (8)
15	Univ of Texas, USA	26	IICB-Kolkata (2), Univ Delhi (2)
16	London School of Hygiene & Public Health, UK	25	BHU-Varanasi (5)
17	King's College, London, UK	25	Jadavpur Univ (6)
18	University of Strathclyde, UK	24	Panjab Univ (10), NIPER-Mohali (7)
19	Wayne State Univ. USA	23	AMU-Aligarh (5), Univ Pune (3)
20	Univ of Illinois at Chicago, USA	23	CMC-Vellore (2), Mumbi Univ Institute of Chemical Technology (2)
21	Universita degli studi di Firenze, Italy	23	Laxmi Pests & Fumigation Ltd (12), APS Univ-Rewa (8)
22	Ohio State University, USA	22	IMTECH-Chandigarh (4), Nizam Inst of Med Sci (3), Univ Pune (3)
23	Freie Universitat Berlin, Germany	21	IICB=Kolkata (6), SNDT Womens Univ (6)
24	Kitasato University, Japan	21	Bose Institute (9), Tripura Univ (9)
25	University of Kentucky, USA	20	Sardar Patel Univ (3), Andhra Univ (3)

(698 papers), artery (467 papers), pancreas (408 papers), arm (338 papers), feet (279 papers), vein (252 papers), nose (215 papers), neck (188 papers), throat (147 papers), genital (141 papers), etcduring 2003-12

On studying the focus of pharmacological research by different body system, the largest number of papers came from nervous system (with 813 papers), followed by gastriintenstinal system (711 papers), immune system (510 papers), cardiovascular or circulatory system (388 papers), respiratory system (258 papers), reproductive system (155 papers), urinary system (133 papers), endocrine system (77 papers), musculoskclion system (36 papers) and integumentary system (2 papers) during 2003-12.

On analyzing the focus of pharmacological research by disease, the largest number of papers was on cancer (with 4020 papers), followed by diabetes (3512 papers), heart diseases (2824 papers), liver disease (1311 papers), tuberculosis (858 papers), measles (855 papers), diarrhea (831 papers), arthritis (806 papers), AIDS/HIV (744 papers), asthma (658 papers), hepatitis (563 papers), malaria (501 papers), blood disease (499 papers), allergy (440 papers), epilepsy (373 papers), etc during 2003–12 (Table 8)

On analyzing the focus of pharmacological research by type of biological activity, the largest number of papers were on observed on antioxidant activity (with 3755 papers), followed by enzyme activity (3212 papers), anti-

Table 8. Distribution of Indian Pharmacological ResearchOutput by Different Type of Disease, 2003–12

S.No	Disease	Number of Papers			S.No	Disease	Number of Papers		
		Plant Based	Non Plant Based	Total			Plant Based	Non Plant Based	Total
1	Cancer	1030	2990	4020	27	Parkinson's Disease	31	107	138
2	Diabetes	1507	2995	3512	28	Leprosy	96	40	136
3	Heart or Cardio disease	641	2183	2824	29	Dental disease	32	90	122
4	Liver disease	949	362	1311	30	Glaucoma	10	103	113
5	Tuberculosis	101	757	858	31	Tetanus	5	104	109
6	Measles	16	839	855	32	Hives	14	80	94
7	Diarrhea	413	418	831	33	Cholera	54	34	88
8	Arthritis	200	606	806	34	Typhoid	22	53	75
9	AIDS/HIV	85	659	744	35	Allergic rhinitis	20	53	73
10	Asthma	308	350	658	36	Conjunctivitis	23	49	72
11	Hepatitis	201	362	563	37	Filiariasis	7	62	69
12	Malaria	155	346	501	38	Chronic bronchitis	36	23	59
13	Blood disease	159	340	499	39	Chronic obstructive pulmonary disease	1	52	53
14	Allergy	41	399	440	40	Rabies	4	39	43
15	Epilepsy	119	254	373	41	Dengue	28	10	38
16	Anemia	81	241	332	42	Enzema	4	30	34
17	Pneumonia	105	208	313	43	Japanese encephalitis	2	30	32
18	Alzheimer's disease	69	214	283	44	Food allergy	10	21	31
19	Stroke	36	198	234	45	Polio	1	21	22
20	Skin disease	123	102	225	46	Chikungunya	1	11	12
21	Leishmaniasis	24	185	209	47	Leptospirosis	0	8	8
22	Schizophrenia	7	194	201	48	Chagas disease	2	6	8
23	Sleep disease	64	133	197	49	Trachoma	2	5	7
24	Dementia	56	119	175	50	Echinococcosis	2	4	6
25	Influenza	0	165	165					
26	Thyroid	23	138	161					

bacterial activity (2983 papers), anti-inflammatory activity (2123 papers), antimicrobial activity (1961 papers), antifungal activity (1807 papers), antineoplastic activity (1796 papers), analgestic activity (1280 papers), antidiabetic activity (1188 papers), anticancer activity (1041 papers), hepatoprotective activity (834 papers), antitumor activity (653 papers), antiviral activity (529 papers), etc during 2003–12 (Table 9).

Institutional Contribution & Impact

In this section, the most productive 147 Indian organizations contributing to Indian pharmacological research during 2003-12 are analysed. These 147 organizations together have contributed 32720 papers, accounting for62.15% share of the total research output in Indian pharmacology. These 147 organizations comprises of 70 universities, 23 research institutes, 16 medical colleges & hospitals, 15 pharmacy schools & colleges, 12 institutes of national importance, 8 engineering colleges and 3 industrial units..

Universities - The top 70 universities together contributed 17441 papers, accounting for 33.13% share of the Indian pharmacological output during 2003-12. These output of these 70 univesities varied from 78 to 1092 papers, with an average productivity per university of 249.16. These 17441 papers by 70 universities have received 59145 citations, leading to the citation impact per paper of 3.39.

The output of these 70 universities arranged in decreasing order of productivity during 2003-12 are Jamia Hamdard, Delhi (1092 papers), followed by Annamalai University (969 papers), Dr Harisingh Gour Univer-

Table 9. Distribution of Indian Pharmacological ResearchOutput by Different Type of Biological Activity, 2003–12

Biological Activity	# of Papers	Biological Activity	# of Papers	Biological Activity	# of Papers
Anti-oxidant Activity	3755	Anti-pyretic activity	297	Anti-nociceptive activity	57
Enzyme activity	3212	Anti-hyperglycemic activity	296	Anti-allergic activity	57
Anti-bacterial activity	2983	Anti-proliferative activity	270	Anti-obesity activity	49
Anti-inflammatory activity	2123	Anti-depressant activity	267	Anti-ulcerodenic activity	46
Anti-microbial activity	1961	Anti-protozoal activity	235	Anti-plasmodial activity	40
Anti-fungal activity	1807	Anti-mycobacterial activity	232	Anti-leishmamania activity	39
Anti-neoplastic activity	1796	Anti-diarrheal activity	139	Anti-acne activity	30
Analgesic activity	1280	Anti-angiogenic activity	105	Anti-emetic activity	23
Anti-diabetic activity	1188	Anti-angiogenic activity	105	Anti-HIV activity	19
Anti-cancer activity	1041	Anti-fertility activity	104	Anti-candidal activity	18
Hepatoprotective activity	834	Anti-epileptic activity	103	Anti-venom activity	18
Anti-tumor activity	653	Hemolytic activity	91	Anti-implantation activity	17
Anti-viral activity	529	Anti-asthmatic activity	78	Anti-trypansoma activity	12
Anti-convulsant activity	485	Anti-hepatotoxic activity	75	Anti-periodic activity	11
Anti-tuberculosis activity	469	Anti-arthritic activity	65	Anti-giardial activity	4
Anti-ulcer activity	415	Anti-spasmodic activity	64	Anti-dengue activity	3
Anti-malarial activity	396	Anti-stress activity	60	Anti-lipase activity	2

sity, Sagar (908 papers), Panjab University, Chandigarh (830 papers), Jadavpur University, Kolkata (804 papers), University of Madras (743 papers), Andhra University (592 papers), MS University of Baroda (535 papers), Kakatia University, Warangal (447 papers), University of Rajasthan, Jaipur (444 papers), University of Delhi (442 papers), Jawaharlal Nehru Technological University, Hyderabad (430 papers) , Bharati Vidyapeeth University, Pune (379 papers), University of Calcutta (361 papers), University of Mysore (349 papers), Banaras Hindu University, Varanasi (348 papers), Aligarh Muslim University (347 papers), Punjabi University, Patiala (332 papers), Sri Venkateswar University, Tirupati (317 papers), Mumbai University Institute of Chemical Technology (265 papers), Guru Nanak Dev University, Amritsar (264 papers), University of Lucknow (260 papers), RTM Nagpur University (252 papers), University of Pune (229 papers), Osmania University (226 papers), SASTRA (218 papers), GJ University of Science & Technology, Hisar (215 papers), Kurukshetra University (209 papers), Kuvempu University (206 papers), University of Mumbai (206 papers), MD University, Rohtak (205 papers), University of Hyderabad (205 papers), Karnataka University (196 papers), University of Allahabad (195 papers), Acharya Nagarjuna Univ (176 papers), Bharathiar University (159 papers), Univ of Kalyani (174 papers), Saurashtra Univ (170 papers), Bharathidasan Univ (159 papers), Gujarat Univ (152 papers), Dr Babasaheb Ambedkar Marathwada Univ (147 papers), SRM Univ (140 papers), Ganpat Univ (139 papers), Sri Krishnadevaraya Univ (138 papers), Madurai Kamraj Univ (135 papers), Jiwaji Univ (128 papers), Pt Ravishankar Shukla Univ (120 papers), Sardar Patel Univ (120 papers), Dibrugarh Univ (119 papers), Utkal Univ (119 papers), ML Sukadia Univ (118 papers), Banasthali Univ (117 papers), Jawaharlal Nehru Univ (116 papers), Univ of Kerala (112 papers), Swami Ramanand TeerthMarathwada Univ (110 papers), Pondicherry Univ (107 papers), Nirma Univ of Science & Technology (107 papers), CS Maharaj Medical Univ (102 papers), HN Bahuguna Univ (96 papers), Kumaun Univ (94 papers), Anna Univ (91 papers), Bundelkhand Univ (95 papers), Mangalore Univ (90 papers), Gulbarga Univ (89 papers), Manipal Univ (84 papers), Amity Univ (83 papers), Univ of Kashmir (82 papers), Punjab Agricultural Univ, Ludhiana (81 papers), Bangalore Univ (81 papers), Karpagam Univ (80 papers), Jaipur National Univ (79 papers), JSS Univ (78 papers).

Research Institutes - The top 23 Indian research institutes together contributed 6721 papers, accounting for 12.77% share of the Indian pharmacological output during 2003–12. These output of these 23 Indian research institutes varied from 82 to 1467 papers, with an average productivity per institute of 292.22. These 6721 papers by 23 Indian research institutes have received 34996 citations, leading to the citation impact per paper of 5.21. The output of these 23 Indian research institutes arranged in decreasing order of productivity during 2003–12 are: Indian Institute of Chemical Technology (IICT), Hyderabad (1467 papers), Central Drug

Research Institute (CDRI), Lucknow (1011 papers), National Institute of Pharmaceutical Education & Research (NIPER), Mohali (817 papers), National Chemical Laboratory (NCL), Pune (444 papers), Indian Institute of Toxicological Research (IITR), Lucknow (437 papers), Indian Institute of Chemical Biology (IICB), Kolkata (293 papers), Bhabha Atomic Research Centre (BARC), Mumbai (273 papers),Indian Institute of Integrated Medicine, Srinagar (220 papers), National Botanical Research Institute, Lucknow (198 papers), Central Leather Research Institute, Chennai (182 papers), Central Institute of Medicinal Plants, Lucknow (182 papers), Indian Association for Cultivation of Science, Kolkata (173 papers), Defence Research & Development Estalishment, Gwalior (158 papers), Indian Veterinary Research Institute, Izatnagar (156 papers), Institute of Nuclear Medicine & Allied Sciences, Delhi (152 papers), Institute of Genomics & Integrated Biology, Delhi (130 papers), Central Food Technological Research Institute, Mysore (115 papers), Bose Institute, Kolkata (113 papers), Indian Agricultural Research Institute, New Delhi (105 papers), Institute of Himalaya Bioresoure Technology, Palampur (99 papers), Central Salt & Marine Chemical Research Institute, Bhavnagar (90 papers), Centre for Cellular & Molecular Biology, Hyderabad (84 papers) and Chittranjan National Cancer Research Institute, Kolkata (82 papers).

Institute of National Importance - The top 12 most productive Indian institutes of national importance together contributed 6721 papers, accounting for 5.03% share of the Indian pharmacological output during 2003-12. These output of these 12 institutes of national importance varied from 87 papers to 614 papers, with an average productivity per institute of 220.75. These 2649 papers by 12 institutes of national importance have received 11271 citations, leading to the citation impact per paper of 4.25. The output of these institutes of national importance arranged in decreasing order of productivity during 2003-12 are: All India Institute of Medical Sciences, New Delhi (614 papers), Indian Institute of Science (IIIS), Bangalore (361 papers), Postgraduate Institute of Medical Education & Research, Chandigarh (313 papers), Indian Institute of Technology, Kharagpur (238 papers), Indian Institute of Technology, Kanpur (188 papers), Indian Institute of Technology, Bombay (186 papers), Jawaharlal Institute of Postgraguate Medical Education & Research, Pondicherry (162 papers), Indian Institute of Technology, Madras (147 papers), Indian Institute of Technology, Delhi (142 papers), Indian Institute of Technology, Roorkee (138 papers), Indian Institute of Technology, Guwahati (111 papers) and National Institute of Mental Health & Allied Sciences, Bangalore (87 papers).

Pharmacy Schools &Colleges - The top 15 most productive Indian pharmacy schools & colleges together contributed 2614 papers, accounting for 4.96% share of the Indian pharmacological output during 2003-12. These output of these 15 most productive Indian pharmacy schools & colleges varied from 77 to 440 papers, with an average productivity per college of 174.27. These 2614 papers by 15 Indian pharmacy schools & colleges have received 4946 citations, leading to the citation impact per paper of 1.89. The output of these Indian pharmacy schools & colleges arranged in decreasing order of productivity during 2003-12 are: Manipal College of Pharmaceutical Science (440 papers), JSS College of Pharmacy (258 papers), LM College of Phamacy (254 papers), Al-Ameen College of Pharmacy (212 papers), Principal KM Kundnani College of Pharmacy (196 papers), Bombay College of Pharmacy (177 papers), CL Baid College of Pharmacy (139 papers), Bharati Vidyapeeth College of Pharmacy, Mumbai (107 papers), AR Patel & GH Patel Institute of Pharmacy (106 papers), Sri BM Shah College of Pharmacy (93 papers), KVS Rao Siddarth College of Pharmacy (90 papers), Rajiv Gandhi Academy of Pharmacy (86 papers), BV Patel Pharmaceutical Education & Research Development PERD Center (79 papers), PES College of Pharmacy (79 papers), Bharti Vidyapeeth College of Pharmacy, Kolhapur (77 papers).

Medical Colleges & Hospital - The top 16 most productive Indian medical colleges & hospitals contributed 1954 papers, accounting for 3.71% share of the Indian pharmacological output during 2003-12. These output of these 16 Indian medical colleges & hospitals varied from 77 to 226 papers, with an average productivity per college of 122.12. These 1954 papers by 16 Indian medical colleges & hospitals have received 4439 citations, leading to the citation impact per paper of 2.27. The output of these Indian medical colleges & hospitals arranged in decreasing order of productivity during 2003–12 are: Kasturba Medical College, Manipal (226 papers), Institute of Medical Sciences, BHU, Varanasi (218 papers), Amala Cancer Hospital & Research Center (173 papers), University College of Medical Sciences, Delhi (153 papers), Christian Medical College, Vellore (150 papers), Pandit Bhagwat Dayal Sharma Postgraduate Institute of Medical Sciences, Rohtak (142 papers), Jawaharlal Nehru Medical College, Aligarh (111 papers), Kasturba Medical College, Mangalore (108 papers), Maulana Azad Medical College, Delhi (102 papers), Dayanand Medical College & Hospital, Ludhiana (99 papers), Madras Medical College (96 papers), Tata Memorial Hospital, Mumbai (88 papers), National Institute of Medical Sciences, Jaipur (86 papers), Lady Harding Medical College, New Delhi (79 papers),

Medical College & Hospital, Kolkata (77 papers) and Sanjay Gandhi Postgraduate Institute of Medical Sciences, Lucknow (77 papers)

Engineering Colleges - The top 8 most productive Indian engineering colleges contributed 1341 papers, accounting for 2.55% share of the Indian pharmacological output during 2003-12. These output of these 8 most productive Indian engineering colleges varied from 77 to 287 papers, with an average productivity per college of 167.62. These 1341 papers by 8 most productive Indian engineering colleges have received 3984 citations, leading to the citation impact per paper of 2.97. The output of these 8 Indian engineering colleges arranged in decreasing order of productivity during 2003-12 are: Birla Institute of Technology & Science (BITS), Pilani (287 papers), Institute of Technology, BHU, Varanasi (239 papers), Birla Institute of Technology & Science, Mesra (221 papers), Vellore Institute of Technology (219 papers), Gandhi Institute of Technology & Management (123 papers), Meerut Institute of Engineering & Technology (106 papers), Sri Seksaria Institute of Technology & Science (90 papers), Anna Univ of Technology, Tirichirapalli (77 papers).

Industry - The top 3 most productive Indian industrial companies contributed 703 papers, accounting for 1.34% share of the Indian pharmacological output during 2003-12. These output of these 3 most productive Indian industrial companies varied from 116 to 432 papers, with an average productivity per college of 234.33. These 703 papers by 3 most productive Indian industrial companies have received 2538 citations, leading to the citation impact per paper of 3.61. The output of these 3 Indian industrial companies arranged in decreasing order of productivity during 2003-12 are: Dr Reddy's Laboratories, Hyderabad (432 papers), Ranbaxy Research Laboratory (156 papers) and Cadilla Healthcare Ltd (116 papers).

Contribution and Impact of Top 35 Most Productivite Indian Organization

The top 35 most productive Indian organizations (consisting of 22 universities, 7 research institutes, 3 institutes of national importance, 1 each pharmacy college, medical college & hospital and industry) involved in pharmacological research have published from 260 to 1467 papers each during 2003-12. These 35 institutions involved together have contributed 35.42% (18646 papers) in the cumulative publications output of India in pharmacological research. The publication profile of these 35 institutions along with their research output, citations received and h-index values are presented in (Table 10). The average publication productivity per organization reported by the top 35 institutions was 532.74 and only 12 organizations have registered higher output than the group average. These are Indian Institute of Chemical Technology, Hyderabad with 1467 papers, followed byJamia Hamdard, Delhi (1092 papers), Central Drug Research Institute, Lucknow (1011 papers), Annamalai University (969 papers), Dr Harisingh Gour University, Sagar (908 papers), Panjab University, Chandigarh (830 papers), National Institute of Pharmaceutical Education & Research, Mohali (817 papers), Jadavpur University, Kolkata (804 papers), University of Madras (743 papers), All India Institute of Medical Sciences, New Delhi (614 papers), Andhra University (592 papers) andMS University of Baroda (535 papers).

The average citation per paper registered by the total papers of these 35 organizations was 3.99 during 2003-12 and 16 organizations have registered higher citation impact than the group average. They are Indian Institute of Toxicological Research, Lucknow with a citation impact per paper of 5.84, followed by Indian Institute of Chemical Technology, Hyderabad (5.50), University of Delhi (5.46), National Institute of Pharmaceutical Education & Research , Mohali (5.44), National Chemical Laboratory, Pune (5.41), Guru Nanak Dev University, Amritsar (5.08), Birla Institute of Technology & Science, Pilan (5.01), Dr Harisingh Gour University, Sagar (5.01), Banaras Hindu University, Varanasi (4.99), Indian Institute of Science, Bangalore (4.88), Indian Institute of Chemical Biology, Kolkata (4.82), Central Drug Research Institute, Lucknow (4.59), University of Madras Panjab University, Chandigarh (4.47), Bhabha Atomic Research Centre, Mumbai (4.23) and Punjabi University, Patiala (4.18).

The average h-index registered by these 35 organizations was 33.97 during 2003-12 and 13 organizations have registered higher h-index value than the group average. They are Indian Institute of ChemicalTechnology, Hyderabad with a h-index value of 118, followed by National Institute of Pharmaceutical Education & Research, Mohali (55), Jamia Hamdard, Delhi (50), Dr Harisingh Gour University, Sagar (48), Panjab University, Chandigarh (48), Central Drug Research Institute, Lucknow (45), University of Madras(43), Jadavpur University, Kolkata (43), Annamalai University (41), National Chemical Laboratory, Pune (38), All India Institute of Medical Sciences, New Delhi (36), Indian Institute of Toxicological Research, Lucknow (35) and University of Delhi (35)

The average share of international collaborative papers (ICP) achieved by 35 top organizations in pharmacological research was 10.58% during 2003-12 and 18 organizations have achieved higher share of ICP than the group average. They are University

of Delhi withICP share of27.60. followed by Birla Institute of Technology & Science, Pilani (21.25%), Sri Venkateswar University, Tirupati (20.50%), Aligarh Muslim University (19.02%), University of Lucknow (18.46%), Indian Institute of Chemical Biology, Kolkata (16.38%), National Institute of Pharmaceutical Education & Research, Mohali (14.69%), Jamia Hamdard, Delhi (14.38%), Mumbai University Institute of Chemical Technology (14.34%), Indian Institute of Toxicological Research, Lucknow (13.50%), Kakatia University (13.20%), University of Calcutta (13.02%), Banaras Hindu University, Varanasi (12.93%), University of Mysore (12.89%), Andhra University (12.16%), Bharati Vidyapeeth University, Pune (11.61), Guru Nanak Dev University, Amritsar (11.36%) and Bhabha Atomic Research Centre, Mumbai (11.36%).

The average share of high cited papers (HCP) achieved by 35 top organizations in pharmacological research was 0.692 during 2003-12 and 10 organizations have achieved higher share of HCP than the group average. They are National Institute of Pharmaceutical Education & Research (NIPER), Mohali with HCP share of2.69%, followed by University of Delhi (1.58%), Bhabha Atomic Research Centre, Mumbai (1.46%), National Chemical Laboratory, Pune (1.35%), Panjab University, Chandigarh (1.32%), Jadavpur University, Kolkata (1.24%), Dr Harisingh Gour University, Sagar (1.10%), Birla Institute of Technology & Science, Pilani (1.04%), Indian Institute of Toxicological Research, Lucknow (0.91%) and Mumbai University Institute of Chemical Technology (0.75%).

Contribution and Impact of Top 30 Most Productive Authors in Pharmacological Research

The top 30 most productive Indian authors involved in pharmacological research have published from 88 to 285 papers each during 2003-12. These 30 authors together have contributed 0.59% (3240 papers) share in the cumulative publications output of India in

Table 10. Productivity and Citation Impact of Top Thirty Five Indian Organizations in Pharmacological Research, 2003–12

		TP	TC	ACPP	HI	ICP	%ICP	HCP	%HCP
1	Indian Institute of Chemical Technology (IICT), Hyderabad	1467	8066	5.50	57	118	8.044	7	0.477
2	Jamia Hamdard, Delhi	1092	4256	3.90	50	157	14.38	7	0.641
3	Central Drug Research Institute (CDRI), Lucknow	1011	4645	4.59	45	81	8.012	6	0.593
4	Annamalai University	969	3084	3.18	41	57	5.882	3	0.31
5	Dr Harisingh Gour University, Sagar	908	4547	5.01	48	63	6.938	10	1.101
6	Panjab University, Chandigarh	830	3709	4.47	48	54	6.506	11	1.325
7	National Institute of Pharmaceutical Education & Research (NIPER), Mohali	817	4444	5.44	55	120	14.69	22	2.693
8	Jadavpur University, Kolkata	804	2986	3.71	43	75	9.328	10	1.244
9	University of Madras	743	3373	4.54	43	66	8.883	2	0.269
10	All India Institute of Medical Sciences, New Delhi	614	1828	2.98	36	63	10.26	4	0.651
11	Andhra University	592	899	1.52	27	72	12.16	1	0.169
12	MS University of Baroda	535	1759	3.29	33	38	7.103	1	0.187
13	Kakatia University	447	1133	2.53	30	59	13.2	2	0.447
14	University of Rajasthan, Jaipur	444	764	1.72	24	19	4.279	0	0
15	National Chemical Laboratory (NCL), Pune	444	2401	5.41	38	37	8.333	6	1.351
16	University of Delhi	442	2412	5.46	35	122	27.6	7	1.584
17	Manipal College of Pharmaceutical Science	440	865	1.97	29	36	8.182	1	0.227
18	Indian Institute of Toxicological Research (IITR), Lucknow	437	2550	5.84	35	59	13.5	4	0.915
19	Dr Reddy's Laboratories, Hyderabad	432	1483	3.43	29	27	6.25	0	0
20	Jawaharlal Nehru Technological University, Hyderabad	430	858	2	19	30	6.977	0	0

Continued...

21	Bharati Vidyapeeth University, Pune	379	967	2.55	30	44	11.61	2	0.528
22	University of Calcutta	361	1272	3.52	22	47	13.02	2	0.554
23	Indian Institute of Science (IIIS), Bangalore	361	1762	4.88	27	17	4.709	0	0
24	University of Mysore	349	1079	3.09	25	45	12.89	2	0.573
25	Banaras Hindu University, Varanasi	348	1736	4.99	31	45	12.93	2	0.575
26	Aligarh Muslim University	347	1348	3.88	29	66	19.02	2	0.576
27	Punjabi University, Patiala	332	1388	4.18	27	10	3.012	1	0.301
28	Sri Venkateswar University, Tirupati	317	775	2.44	21	65	20.5	0	0
29	Postgraduate Institute of Medical Education & Research (PGIMER), Chandiagarh	312	976	3.13	26	25	8.013	1	0.321
30	Indian Institute of Chemical Biology (IICB), Kolkata	293	1411	4.82	29	48	16.38	2	0.683
31	Birla Institute of Technology & Science (BITS), Pilani	287	1438	5.01	32	61	21.25	3	1.045
32	Bhabha Atomic Research Centre (BARC), Mumbai	273	1156	4.23	28	31	11.36	4	1.465
33	Mumbai University Institute of Chemical Technology	265	989	3.73	25	38	14.34	2	0.755
34	Guru Nanak Dev University, Amritsar	264	1341	5.08	29	30	11.36	0	0
35	University of Lucknow	260	680	2.62	23	48	18.46	0	0
	Total	18646	74380	3.99	33.97	1973	10.58	129	0.69

TP=Total Papers; TC=Total Citations; ICP=International Collaborative Papers; HCP=High Cited Papers

pharmacological research. The publication profile of these 30 authors along with their research output, citations received and h-index values are presented in (Table 11). The average publication productivity per author reported by the top 30 authors was 108 and only 10 authors have registered higher output than the group average. They are JS Yadav with 285 papers, followed A Kamal (147 papers), D. Sriram (140 papers A Kumar (138 papers), P. Yogeeswari (136 papers), SK Kulkarn (128 papers), R. Manavalan (124 papers), NR Srinivas (124 papers), SP Vyas (121 papers) and-BVS Ready (108 papers).

The average citation per paper registered by the total papers of these 30 authors was 5.03 during 2003-12 and 14 authors have registered higher citation impact than the group average. They are K Roy with a citation impact per paper of 8.36, followed by JS Yadav (7.55), B. Das (7.10), K Chopra (7.03), A Kamal (7.00), BVS Ready (6.84), P. Kumar (6.72), D. Sriram (6.64), SP Vyas (6.36), P. Yogeeswari (6.32), SK Jain (5.87), SK Kulkarni (5.78), RK Khar (5.47) and J Ali (5.04).

The average h-index registered by these 30 authors was 20.57 during 2003-12 and 15 organizations have registered higher h-index value than the group average. They are JS Yadav with a h-index value of 37, followed by SK Kulkarni (30), D. Sriram (27), P. Yogeeswari (27), A Kamal (26), SP Vyas (26), B. Das (25), BVS Ready (25), SK Jain (25), RK Khar (25), K Chopra (24R Chandra (24), R Panchagnula (23), P. Kumar (22) and J Ali (21).

The average share of international collaborative papers (ICP) achieved by 30 authors in pharmacological research was 8.52% during 2003-12 and 10 authors have achieved higher share of ICP than the group average. They are R Chandra withICP share of27.38%. followed by R Panchagnula (23.08%), D. Sriram (19.29%), S Babootha (18.99%), P. Yogeeswari (18.38%), J Ali (13.89%), K Roy (12.50%), P. Kumar (9.88%), A Kumar (9.42%%) and KK Pillai (8.64%).

The average share of high cited papers (HCP) achieved by 30 authors in pharmacological research was 0.83 during 2003-12 and 10 authors have achieved higher share of HCP than the group average. They are RK Khar with HCP share of4.76%, followed by SK Jain (4.49%), R Panchagnula (3.85%), K Roy (2.50%), AK Bansal (2.25%), FJ Ahmad (2.17%), J Ali (1.85%), S Babootha (1.27%), G.Kuttan (1.11%) and JS Yadav (1.05%).

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Indian scientists have published 12438 and 6643 papers in 30 each most productive Indian and foreign journals during 2003–12, which account for 23.63% and 12.62% share of Indian pharmacological output during 2003–12 (Tables 12–13).

Table 11. Productivity & Citation Impact of Thirty Most Productive Authors in Pharmacologiy Research, 2003–12

S.No	Name of Author	Affiliation of Author	TP	TC	ACPP	HI	ICP	%ICP	HCP	%HCP
1	JS Yadav	Indian Institute of Chemical Technology, Hyderabad	285	2153	7.55	37	19	6.67	3	1.05
2	A Kamal	Indian Institute of Chemical Technology, Hyderabad	147	1029	7.00	26	11	7.48	0	0.00
3	D. Sriram	Birla Institute of Technology & Science, Pilani	140	929	6.64	27	27	19.29	1	0.71
4	A Kumar	University of Delhi	138	657	4.76	20	13	9.42	1	0.72
5	P. Yogeeswari	Birla Institute of Technology & Science, Pilani	136	859	6.32	27	25	18.38	0	0.00
6	SK Kulkarni	Panjab University, Chandigarh	128	740	5.78	30	7	5.47	0	0.00
7	R. Manavalan	Annamalai University	124	175	1.41	10	4	3.23	0	0.00
8	NR Srinivas	Dr Reddy Laboratories Ltd., Hyderabad	124	298	2.40	16	9	7.26	0	0.00
9	SP Vyas	Dr Harisingh Gour University, Sagar	121	770	6.36	26	6	4.96	0	0.00
10	BVS C2Ready+C33	Indian Institute of Chemical Technology, Hyderabad	114	780	6.84	25	6	5.26	0	0.00
11	J Ali	Jamia Hamdard University, Delhi	108	544	5.04	21	15	13.89	2	1.85
12	RK Khar	Jamia Hamdard University, Delhi	105	574	5.47	25	4	3.81	5	4.76
13	J Mukkanti	JN Technological University, Hyderabad	102	332	3.25	14	3	2.94	0	0.00
14	SL Bodhankar	Bharthi Vidyapeeth University, Pune	108	298	2.76	14	8	7.41	0	0.00
15	B. Das	Indian Institute of Chemical Technology, Hyderabad	94	667	7.10	25	2	2.13	0	0.00
16	FJ Ahmad	Jamia Hamdard University, Delhi	92	417	4.53	17	7	7.61	2	2.17
17	K Chopra	Panjab University, Chandigarh	90	633	7.03	24	1	1.11	0	0.00
18	G.Kuttan	Amala Cancer Research Center, Trissur	90	393	4.37	19	3	3.33	1	1.11
19	R Suresh	JSS College of Pharmacy, Ootacunand	87	178	2.05	18	5	5.75	0	0.00
20	AK Bansal	National Institute of Pharmaceutical Education & Research, Mohali	89	344	3.87	19	6	6.74	2	2.25
21	R Chandra	University of Delhi	84	398	4.74	24	23	27.38	0	0.00
22	R Mullangi	Dr Reddy Laboratories Ltd., Hyderabad	82	235	2.87	13	3	3.66	0	0.00
23	KK Pillai	Jamia Hamdard University, Delhi	81	194	2.40	13	7	8.64	0	0.00
24	K Roy	Jadavpur University	80	669	8.36	16	10	12.50	2	2.50
25	S Babootha	Jamia Hamdard University, Delhi	79	342	4.33	20	15	18.99	1	1.27
26	P. Kumar	National Chemical Laboratorty, Pune	81	544	6.72	22	8	9.88	0	0.00
27	R Panchagnula	National Institute of Pharmaceutical Education & Research, Mohali	78	288	3.69	23	18	23.08	3	3.85
28	SK Jain	Dr Harisingh Gour University, Sagar	89	522	5.87	25	7	7.87	4	4.49

Continued...

29	K Pathak	Rajeev Academy of Pharmacy, Mathura	76	252	3.32	13	4	5.26	0	0.00
30	SJ Surana	Patel College of Pharmacy, Dhule, Maharashtra	88	98	1.11	8	0	0.00	0	0.00
	Total		3240	16312	5.03	20.87	276	8.52	27	0.83

TP=Total Papers; TC=Total Citations; ICP=International Collaborative Papers; HCP=High Cited Papers

Table 12. Most Productive Indian Journals Publishing Pharmacology Research Papers from Indian Scientists, 2003–12

S.No	Name of Journal	# of Papers	S.No	Name of Journal	# of Papers
1	International Journal of Pharmacy & Pharmaceutical Sciences	1806	18	Pharmacognosy Journal	318
2	Indian Journal of Pharmaceutical Sciences	1542	19	Indian Journal of Forsenic Medicine & Toxicology	281
3	International Journal of Pharmatech Research	1157	20	Indian Journal of Pharmaceutical Education & Research	267
4	Journal of Anaesthesiology & Clinical Pharmacology	1151	21	Journal of Natural Remedies	261
5	Indian Drugs	1144	22	International Journal of Pharmaceutics	246
6	Research Journal of Pharmaceutical Biological & Chemical Sciences	1143	23	Journal of Global Pharma & Technology	208
7	Indian Journal of Pharmacology	965	24	Journal of Natural Remedies	261
8	International Journal of Pharmaceutical Sciences Review & Research	877	25	Biomedical & Pharmacological Journal	228
9	Journal of Chemical & Pharmaceutical Research	858	26	International Journal of Research in Pharmaceutical Sciences	225
10	Biosciences Biotechnology Asia	695	27	Journal of Global Pharma Technology	208
11	Research Journal of Pharmacy & Technology	668	28	Toxicology International	205
12	Asian Journal of Pharmaceutical & Clinical Research	651	29	International Journal of Green Pharmacy	196
13	Indian Journal of Chemistry Section B.Organic & Medicinal Chemistry	599	30	International Journal of Pharmaceutical REsearch	194
14	Indian Journal of Physiology & Pharmacology	567		Total	12438
15	International Journal of Drug Development & Research	424		Total of Country	52645
16	Journal of Applied Pharmaceutical Science	417		Share of top 30 Indian journals in country output	12.62%
17	International Journal of Pharmacy & Technology	369			

SUMMARY

India has published 52645 papers in pharmacology, as indexed and covered in Scopus database during 2003–12. Its annual research output has increased from 2016 to 10684 papers from 2003 to 2012, witnessing an annual average growth rate of 21.13%. India ranks at 3rd position in global output with 7.52% publication share during 2003-12, which has increased from 4.34% to 9.95%and rank from 6th to 3rd from 2003–07 to 2008-12. India's research impact, as measured by average citation per paper was 2.87 during 2003–12. Of India's total papers in pharmacology, 52.03% papers received 1 or more citations and out of these cited

Table 13. Most Productive Foreign Journals Publishing Pharmacology Research Papers from Indian Scientists, 2003–12

S.No	Name of Journal	# of Papers	S.No	Name of Journal	# of Papers
1	Tetrahedron Letters	2939	18	European Journal of Pharmacology	243
2	Pharmacologyonline	1118	19	Biomedical Chromatography	234
3	Tetrahedron	939	20	Journal of Enzyme Inhibition & Medicinal Chemistry	232
4	Biorganic & Medicinal Chemistry Letters	891	21	Pharmazie	228
5	European Journal of Medicinal Chemistry	820	22	Chemio-Biological Interactions	214
6	Medicinal Chemistry Research	698	23	Fitoterapia	212
7	Journal of Ethnopharmacology	596	24	Life Sciences	197
8	Der Pharmacia Lettre	495	25	Tetrahedron Asymmetry	197
9	Biorganic & Medicinal Chemistry	490	26	Journal of Pharmacy & Pharmacolohy	189
10	Bulletin of Environment Contamination & Toxicology	470	27	Chemical & Pharmaceutical Bulletin	185
11	AAPS PharmaSciTech	417	28	Acta Pharmaceutica	181
12	Pharmaceutical Biology	351	29	Current Drug Delivery	176
13	Food & Chemical Toxicology	287	30	Drug Development & Industrial Pharmacy	176
14	Phytotherapy Research	334		Total	6643
15	Journal of Pharmaceutical & Biomedical Analysis	303		Total of Country	52645
16	Journal of Pharmaceutical Science & Research	285		Share of top 30 foreign journals in country output	12.62%
17	Acta Polonia Pharmaceutical Drug Research	246			

papers,29.77% (25254 papers) received from 1-9 citations, 11.53% (6070 papers) from 10-19 citations, 4.94% (2599 papers) from 20-29 citations, 2.23% (1173 papers) from 30-39 citations, 1.19% (629 papers) from 40–49 citations, 1.35% (711 papers) from 50-74 citations, 0.39% (205 papers) from 75-99 citations and 0.43% (227 papers) 100 and above citations during 2003-12. Of India's 227 high cited papers, 192 papers received citations from 100 to 195, 22 papers from 201 to 287 citations, 8 papers from 304 to 385 citations, 3 papers from 400 to 499 citations, 1 paper each 504 and 705 citations since their publication up to December 2013. Out of 227 high cited papers published by Indian scientists in pharmacology, 40 papers involve international collaboration and 48 national collaborations.

India's international collaborative share in its total research output was 8.70% during 2003–12, which decreased from 10.20% to 8.21% from 2003–07 to 2008–12. The largest contribution in India's international collaboration came from USA (with 38.21% share), followed by UK (8.97% share), Germany (6.26%), Saudi Arabia (5.15%), Malaysia (5.15%), South Korea (4.98%), Japan (4.56%), France (3,95%), Canada (3.40%), Australia (3.27%), Belgium (3.23%), Italy (3.08%), Switzerland (2.36%), China (2.33%) etc.The five geographical states, namely Maharashtra, Andhra Pradesh, Tamil Nadu, Karnataka and Uttar Pradesh individually contributed publication share from 10.21% to 13.46% and together contributed 56.27% share to total Indian pharmacological output during 2003-12.

In terms of keyword subject analysis, the major focus of research was on drug synthesis (with 6553 papers), followed by drug structure (5514 papers), drug screening (5099 papers), drug formulation (4730 papers), drug effect (4225 papers), drug efficacy (3987 papers), drug delivery system (3516 papers), drug solubility (3160 papers), drug mechanism (3095 papers), drug stability (2647 papers), drug isolation (2370 papers), drug bioavailability (1793 papers), drug dose response relationship (1760 papers), drug safety (1723 papers), drug potency (1649 papers), drug design (1464 papers), drug absorption (1348 papers), drug half life (973 papers), drug delivery system (969 papers), etc during 2003-12. The largest focus of pharmacological research was

cancer (with 4020 papers), followed by diabetes (3512 papers), heart diseases (2824 papers), liver disease (1311 papers), tuberculosis (858 papers), measles (855 papers), diarrhea (831 papers), arthritis (806 papers), AIDS/HIV (744 papers), asthma (658 papers), hepatitis (563 papers), malaria (501 papers), blood disease (499 papers), allergy (440 papers), epilepsy (373 papers), etc during 2003–12.

The top 147 most productive Indian organizations (including 70 universities, 23 research institutes, 16 medical colleges & hospitals, 15 pharmacy schools & colleges, 12 institutes of national importance, 8 engineering colleges and 3 industrial units) contributed 62.15% share (32720 papers) in Indian publication output during 2003–12. The 70 universities accounted for 33.13% share in India's publications output, with average productivity per university of 249.16 (varying from 78 to 1092 papers) and citation impact per paper of 3.39. The 23 Indian research institutes accounted for 12.77% publication share in India's total output, with average productivity per institute of 292.22 and citation impact per paper of 5.21. The 12 institutes of national importance accounts for 5.03% publication share in India's output, with average productivity per institute of 220.75 (varying from 87 to 614 papers) and citation impact per paper of 4.25. The 15 pharmacy schools and colleges accounts for 4.96% publication's share in India's output, with average productivity per college of 174.27 (varying from 77 to 440 papers) and citation impact per paper of 1.89. The 16 Indian medical colleges & hospitals accounts for 3.71% publication share in India's output, with average productivity og 122.12 (varying from 77 to 226 papers) and the citation impact per paper of 2.27. The 8 engineering colleges accounts for 2.55% share of the Indian pharmacological output, with average productivity per college of 167.62 (varying from 77 to 287 papers) and the citation impact per paper of 2.97. The 3 industrial companies accounts for 1.34% share of the Indian pharmacological output, with average productivity of 234.33 (varying from 116 to 432 papers) and the citation impact per paper of 3.61.

The 35 most productive Indian organizations, accounted for 35.42% share of India's output, with average productivity of 532.74 (varying from 260 to 1467 papers), citation impact per paper of 3.99, average h-index of 33.97, average international collaborative share of 10.58% and average share of high cited papers of 0.692% during 2003–12. The 35 most productive Indian authors involved in pharmacological research accounts for 0.59% publication share of India's research output, with average productivity of 108, average citation per paper of 5.03, average h-index of 20.57, average share of international collaborative papers of

8.52% and average share of high cited papers of 0.83% during 2003–12. The 30 most productive Indian and foreign journals each accounted forfor 23.63% and 12.62% publication's share of Indian pharmacological output during 2003–12

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