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REVIEW

Pharmaceutical research in the Kingdom of Saudi Arabia: A scientometric analysis during 2001–2010

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Abstract Studies on the performance of Saudi Arabia in the pharmaceutical science research using quantitative and qualitative measures. They analyze the productivity and global publication share and rank of the top 15 countries. The author studies Saudi Arabia's publications output, growth and citation quality, international collaborative publication share and most important the collaborating partners, contribution and citation impact of its top 15 organizations and authors, productivity patterns of its top publishing journals and characteristics of its highly cited papers.

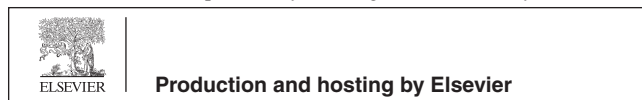© 2013 Production and hosting by Elsevier B.V. on behalf of King Saud University.

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1. Introduction

Despite of incredible advances in the diagnosis and treatment of various diseases, the incidence, prevalence, morbidity and mortality resulting from these diseases continue to escalate. Regardless, the wealth of information in internet, latest research trends, and many other health databases and increasing number of drugs available in the market, the progress to reduce medical need and disease burden is low in both developed and under developed countries. For ages, pharmaceutical products have been one of the main therapeutics to the majority of the less privileged population. The potential of the drugs has attracted the attention of the developed world, to tap their benefits to identify better and safe drugs to combat human diseases, while in the poor nations these products continue to provide health benefits to the diversified categories of patients (Fura, 2006; György and Gergely, 2006). The combined efforts of all public and private R&Ds worldwide bring around only few drugs directed against completely novel mechanisms successfully to market each year. Most drugs have had some therapeutic benefit, and some had phenomenal impact on mortality and morbidity, such as the anti-tumor agents. However, in many diseases, for e.g. HIV, Diabetes, and Cancer the cure has not been identified yet. The impact of genomics and proteomics is additionally creating an explosion in the number of drug targets. Today's drug therapies are based solely on approximately 500 biological targets, while, in 10 years' time, the number of targets could well reach 10,000. The increasing demand for new small molecules led to the invention of new technologies in the field of Pharmaceutical Sciences. Ever-increasing understanding of trends in pharmaceutical research, the community continues to struggle with finding solutions to identify lead molecules (William and Lloyd, 1998; Stephen et al., 2002). The present study is focused on an oil rich country of Middle East, the Kingdom of Saudi Arabia. With emerging globalization of science and education, the challenge of education and research needs in Saudi Arabia has opened new frontiers. As it is moving forward in most of the areas of research and setting up many research centers all over the country, majority of Saudi universities' prime interest is at advancing research in individual fields and enhancing the research atmosphere (AlAli, 2000; Simon and Yousif, 2012). The greatest breakthrough during recent years is expanding the role of pharmacists in the developing countries (Yousif, 2011). Saudi Arabia sets as an example of identifying the primary role in clinical pharmacy, drug discovery and research. Hence, pharmaceutical research is at the forefront and one of the strategic priorities in Saudi Arabia. Our main aim is to study and analyze the research output of Saudi Arabia and to identify highly productive institutes and authors.

Few scientometric studies have been published in this area. Reddy and Mahesh Kumar (2006) provide a scientometric analysis of world papers published by 57 countries in 10 major sub-specialities appearing in three leading international journals during the ten year period. Dotson et al. (2011) analyzed changes in the authorship and characteristics of articles in pharmacy journals during the 20 year period. In the field of bibliometrics of country output in pharmacology only a few studies have been carried out on India(Kaur and Gupta, 2009; Ahila et al., 2011; Gupta et al., 2011), China (Li et al., 2010) and Spain (Bordon and Barrigon, 2005) which deal with different facets of pharmacological research, its growth, global publication share and rank, international collaboration, institutional and authors productivity profile, etc.

1.1. Objectives

The main objective of present analysis in this paper is to analyze the Saudi Arabian contribution in the pharmaceutical research during the last 10 years from 2001–10 with a view: (i) to study the productivity profile of the world's top 15 most productive countries; (ii) to study the Saudi Arabian research output, citation impact, and international collaboration share and identify the leading collaborating partner countries; (iii) to study the contribution and citation impact of its most productive institutions & authors; (iv) to study the media of communication in most productive journals, and (v) to study the characteristics of highly cited papers.

2. Methodology and source used

This study was undertaken based on the publication data from Saudi Arabia and also identifies the top 15 most productive countries in the field of pharmaceutical research. Data for the present study were retrieved from the Scopus international multidisciplinary bibliographical database [http://www.scopus.com/search/] for the last ten years (2001–2010). The search strategy string used to retrieve the main data on research output, institutions, authors and major journals of Saudi Arabia is as follows:

Table 1 Publications output, share & rank of top 15 countries in pharmaceutical sciences, 2001–10.

Country	Publications output			Publications share			Publications rank		
	2001–05	2006–10	2001–10	2001–05	2006–10	2001–10	2001–05	2006–10	2001–10
USA	68351	83676	152027	24.59	24.41	24.49	1	1	1
China	11859	34529	46388	4.27	10.07	7.47	5	2	2
Japan	22602	23466	46068	8.13	6.85	7.42	2	4	3
UK	18602	21684	40286	6.69	6.33	6.49	3	5	4
Germany	16286	18751	35037	5.86	5.47	5.64	4	6	5
India	9449	23897	33346	3.40	6.97	5.37	8	3	6
Italy	10280	13992	24272	3.70	4.08	3.91	7	7	7
France	10510	12042	22552	3.78	3.51	3.63	6	8	8
Canada	8298	9885	18183	2.99	2.88	2.93	10	9	9
Spain	8442	9227	17669	3.04	2.69	2.85	9	10	10
South Korea	5356	9188	14544	1.93	2.68	2.34	12	11	11
Brazil	3918	7879	11797	1.41	2.30	1.90	14	12	12
Netherlands	5591	5950	11541	2.01	1.74	1.86	11	14	13
Australia	4823	6671	11494	1.74	1.95	1.85	13	13	14
Switzerland	3629	4736	8365	1.31	1.38	1.35	15	15	15
World	277907	342774	620681	100.00	100.00	100.00			

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AFFIL(saudi arabia) AND PUBYEAR > 2000 AND PUBYEAR < 2011 AND (LIMIT-TO(SUBJAREA, "PHAR")) AND (LIMIT-TO(AU-ID, "Abdel-Aziz, Alaa A M" 8605268800))

AFFIL(saudi arabia) AND PUBYEAR > 2000 AND PUBYEAR < 2011 AND (LIMIT-TO(SUBJAREA, "PHAR")) AND (LIMIT-TO(EXACTSRCTITLE, "Journal of Pharmaceutical and Biomedical Analysis"))

For citations data, three year, two year and one year citations window has been used for computing average citations per paper from Saudi Arabia during 2001–2008, 2009 and 2010. For searching and calculating the total international collaborative papers, a separate search strategy, which combines Saudi Arabia's collaboration with 140 major countries, was also prepared.

3. Analysis

3.1. Global publication output in pharmaceutical sciences

The publication output of the top 15 most productive countries ranges from 1.35% to 24.49% during 2001–10. The largest contribution is made by USA with 24.49% share, followed far behind by China (7.47% share), Japan (7.42% share), U.K (6.49% share), Germany (5.64% share), India (5.37% share), Italy, France, Canada, Spain and South Korea (with publication share varying from 2.34% to 3.91%), Brazil, Netherlands, Australia and Switzerland (with publication share varying from 1.35% to 1.90%). The publication share has increased in China by 5.8%, followed by India (3.57%), Brazil (0.89%), South Korea (0.75%), Italy (0.38%), Australia (0.21%) and Switzerland (0.07%), as against decrease by 1.28% in Japan, followed by Germany (0.39%), U.K

(0.36%), Spain (0.35%), France and Netherlands (0.27% each), USA (0.18%) and Canada (0.11%) from 2001–05 to 2006–10. In terms of publication rank, countries which have improved their global rank are China (from 5th to 2nd), India (from 8th to 3rd), Canada (from 10th to 9th), South Korea (from 12th to 11th) and Brazil (from 14th to 12th), in contrast to countries losing their rank such as Japan (from 2nd to 4th), UK (from 3rd to 5th), Germany (from 4th to 6th), France (from 6th to 8th), Spain (from 9th to 10th) and Netherlands (from 11th to 14th) from 2001–05 to 2006–10. For other countries, global publications rank has remained the same during the above mentioned period (Table 1).

3.2. Saudi Arabia's publication output, citation impact and international collaboration

The research output of Saudi Arabia in pharmaceutical science consists of 1386 papers during 2001–10, which has increased from 111 papers in 2001 to 301 papers in 2010, registering an annual average growth rate of 14.21%. The cumulative research output of Saudi Arabia in pharmaceutical science has increased from 567 papers during 2001–05 to 819 papers during 2006–10, witnessing a growth rate of 44.44%. The global share of Saudi Arabia was only 0.50% during 2001–10. The average citation impact per paper registered for total papers in pharmaceutical science of Saudi Arabia was 3.36, which marginally decreased from 3.38 during 2001–05 to 3.35 during 2006–10 (Table 2).

The international collaborative output of Saudi Arabia in pharmaceutical science consists of 562 papers, constituting 40.55% share of its total publications output during 2001–10. The share of international collaborative output of Saudi Arabia has increased from 32.45% during 2001–05 to 46.15% during 2006–10 (Table 2). Of the total international collaborative papers published by Saudi Arabia in pharmaceutical science with different countries, 15 countries have published 8 or more papers. The largest number of international collaborative papers (247 papers, 43.95% share) of Saudi Arabia is published with Egypt, followed by USA (88 papers, 15.66% share), India (70 papers, 12.46% share), U.K.

Table 2 Saudi Arabia: Research output, citation impact and international collaborative papers in pharmaceutical science 2001–10.

= Publication year	Total papers	Total citations	ACPP	International collaborative papers (ICP)	Share of ICP	Total citations (of ICP)	ACPP (of ICP)
2001	111	315	2.84	25	22.52	118	4.72
2002	122	416	3.41	34	27.87	130	3.82
2003	120	396	3.30	49	40.83	203	4.14
2004	102	340	3.33	41	40.20	150	3.66
2005	112	449	4.01	35	31.25	224	6.40
2006	96	470	4.90	21	21.88	125	5.95
2007	115	590	5.13	36	31.30	218	6.06
2008	132	524	3.97	57	43.18	288	5.05
2009	175	560	3.20	78	44.57	344	4.41
2010	301	600	1.99	186	61.79	433	2.33
2001–05	567	1916	3.38	184	32.45	825	4.48
2006–10	819	2744	3.35	378	46.15	1408	3.72
20001–10	1386	4660	3.36	562	40.55	2233	3.97

(40 papers, 7.12% share), Germany and Japan (20 papers, 3.56% share each), Canada (19 papers, 3.38% share), Sudan (16 papers, 2.85% share), etc. The international collaborative share of Saudi Arabia has increased by 11.21% with Egypt, followed by India (8.82%), Pakistan (5.03%), Canada (2.6%), Sweden (2.38%), Japan (0.44%), Sudan (0.19%) and U.K (0.07%), as against decrease by 7.42% by USA, followed by Turkey (5.73%), Kuwait (1.93%), Jordan (1.67%), Belgium (1.66%), Germany (0.36%) and United Arab Emirates (0.04%) from 2001–05 to 2006–10 (Table 3).

3.3. Focus of pharmacological research

3.3.1. Organs

If we study organ-wise the focus of research, we can get ideas regarding the nature of pharmaceutical research being probed in Saudi Arabia. The maximum focus of pharmaceutical research in Saudi Arabia during 2001–10 has been on liver (with 169 papers), followed by kidney (102 papers), heart (84), muscle (56), stomach (49), skin (48), brain (43), breast (42), eye (16), artery (14), pancreas (12), ear (8), throat (5), genital (4), feet (3) and neck (2).

3.3.2. Disease

The maximum output of pharmaceutical research has been reported on cancer (with 149 papers), followed by heart diseases (104 papers), diabetes (61 papers), respiratory infection (26 papers), blood disorders (22), tuberculosis (15), depression (14 papers), HIV/AIDS (10), diarrhea (10), epilepsy (10 papers), pneumonia (9), malaria (9), hepatitis (9 papers), cirrhosis (6), leishmaniasis (6), etc.

3.3.3. Pharmacological activity

The largest pharmaceutical activity reported in the literature was on enzyme activity (with 125 papers), followed by anti-oxidant activity (87 papers), anti-neoplastic activity (70 papers), anti-inflammatory activity (54 papers), anti-microbial activity (40 papers), anti-bacterial activity (27 papers), anti-fungal activity (22 papers), analgesic activity (20 papers), anti-viral activity (17 papers), etc.

3.4. Most productive organizations – contribution and impact

The top 15 most productive Saudi Arabian organizations involved in pharmaceutical research together have published 1336 during 2001–10. The publications profile of these 15 Saudi Arabian organizations along with their research output, citations received and h-index values are presented in Table 4. These 15 organizations together have contributed 96.39% share (with 1336 papers) in the cumulative publications output of Saudi Arabia, with an average of 89.6 papers per organization. The productivity of these organizations varies from 14 to 505 during 2001–10. Four organizations have contributed more than the average productivity of all organizations. These are King Saud University, Coll of Pharmacy with 505 papers, followed by King Saud University, (185 papers), King Faisal Specialist Hosp & Research Centre (170 papers) and King Abdul Aziz University, Jeddah (109 papers). The average citation per paper registered by the total papers of these 15 Saudi Arabian organizations was 3.41 (varying from 1 to 5.21) during 2001–10. Five organizations have registered higher impact than the group average of all organizations. These are King Faisal Specialist Hosp & Reseach Centre with an average citation per paper of 5.21, followed by Taibah University (5.03), King Saud University, Medical Coll (4.79), King Fahd University of Petroleum & Minerals (4.76) and King Khalid University (3.50). The average h-index of all Saudi Arabian organizations was 10.60 (varying from 4 to 27). Six organizations have scored a higher value of h-index than the average value of h-index of all organizations. These are King Saud University, Coll of Pharmacy with h-index value of 27, followed by King Faisal Specialist Hosp & Research Centre (20), King Saud University (16), King Saud University, Medical Coll (14), King Abdulaziz University (12) and King Fahd University of Petroleum & Minerals (11) (Table 4).

3.5. Most productive authors – contributions and impact

As seen in Table 5, it is clear that the top 15 contributors from Saudi Arabia are affiliated to the following organizations: King Saud Univ, Riyadh (12 authors), Al Qaseem University (one author), Armed Forces Hosp, Riyadh (one author) and King Abdulaziz University (one author). The 15 most productive authors have together contributed a total of 419 papers, constituting 30.23% share of the total output of Saudi Arabia and registering an average productivity per author of 27.93. Four authors have contributed more than the average productivity of all authors. They are H.Y. Aboul-Enein with 85 papers, followed by A. Al-Shabanah (43 papers), I.A. Alsarra

Table 3 Saudi Arabia: International collaborative papers & share in pharmaceutical science 2001–10.

Period	International collaborative publications			Share of international collaborative papers		
	2001–05	2006–10	2001–10	2001–05	2006–10	2001–10
Egypt	67	180	247	36.41	47.62	43.95
USA	38	50	88	20.65	13.23	15.66
India	12	58	70	6.52	15.34	12.46
UK	13	27	40	7.07	7.14	7.12
Germany	7	13	20	3.80	3.44	3.56
Japan	6	14	20	3.26	3.70	3.56
Canada	3	16	19	1.63	4.23	3.38
Pakistan	0	19	19	0.00	5.03	3.38
Sudan	5	11	16	2.72	2.91	2.85
Turkey	12	3	15	6.52	0.79	2.67
Jordan	6	6	12	3.26	1.59	2.14
Belgium	5	4	9	2.72	1.06	1.60
United Arab Emirates	3	6	9	1.63	1.59	1.60
Sweden	0	9	9	0.00	2.38	1.60
Kuwait	5	3	8	2.72	0.79	1.42
Total	184	378	562	100.00	100.00	100.00

Table 4 Productivity and citation impact of top 15 Saudi Arabian organizations in pharmaceutical science, 2001–10.

Name of the Institution	TP	TC	ACPP	H-Index	ICP	%ICP	HCP	%HCP
King Saud University, Coll of Pharmacy	505	1626	3.22	27	160	31.68	0	0
King Saud University	185	580	3.14	16	85	45.95	1	0.54
King Faisal Specialist Hosp & Reseach Centre	170	885	5.21	20	82	48.24	1	0.59
King Abdulaziz University	109	351	3.22	12	51	46.79	0	0.00
King Saud University, Coll of Science	67	170	2.54	10	16	23.88	0	0.00
King Faisal University	59	96	1.63	8	28	47.46	1	1.69
King Saud University, Medical Coll	53	254	4.79	14	11	20.75	0	0.00
Taibah University	37	186	5.03	7	16	43.24	0	0.00
Riyadh Military Hospital	35	82	2.34	7	5	14.29	0	0.00
King Fahd University of Petroleum & Minerals	25	119	4.76	11	9	36.00	0	0.00
King Khalid University	24	84	3.50	6	16	66.67	0	0.00
Al Qasim University	21	28	1.33	4	9	42.86	0	0.00
King Khalid University Hosp	17	56	3.29	7	1	5.88	0	0.00
Um Al Qura University	15	15	1.00	4	3	20.00	0	0.00
Ministry of Health, Saudi Arabia	14	21	1.5	6	5	35.7	0	0
Total	1336	4553	3.41	10.6	497	37.2	3	0.22
Total Saudi Arabia Output	1386							
Share of the Top 14 Organizations in total Saudi Arabia Output	96.39							

(36 papers) and F.F. Belal (30 papers). The 419 publications contributed by the top 15 authors have received 1548 citations, registering a citation impact per paper of 3.69 (varying from 1.83 to 7.47). Seven authors have registered higher impact than the average citation impact per paper of all authors. They are A.A.M. Abdel-Aziz with a citation impact per paper of 7.47, followed by B.H. Ali (6.17), S.A. Rostom (6.13), A.A. Al-Majed (4.56), F.S. El-Feraly (4.19) and H.Y. Aboul-Enein (3.82). The top 15 most productive authors have registered an average h-index of 9.06 (varying from 4 to 16). Five authors have registered higher value of h-index than the average value of h-index of all authors. They are H.Y. Aboul-Enein with a h-index value of 16, followed by A. Al-Shabanah (14), A.A. Al-Majed (12), B.H. Ali (11) and F.F. Belal (11). The 15 authors have received an average international collaborative share of 31.98% (varying from 0.0% to 93.75%). Four authors have received higher share than the average share of international collaborative papers of all authors. They are F.S. El-Feraly with internationally collaborative papers share of 93.75%, followed by

A.A.M. Abdel-Aziz (73.33%), H.Y. Aboul-Enein (67.06%) and S.A. Rostom (46.67%) [Table 5].

3.6. Research communication in high productive journals

The 15 most productive domestic and foreign journals publishing Saudi Arabian research papers together contributed 524 papers in pharmaceutical science, which accounted for 37.81% of the total output of Saudi Arabia during 2001–10. The cumulative share of these 15 journals in total publications output of Saudi Arabia in pharmaceutical science has decreased from 45.50% during 2001–05 to 32.48% during 2006–10 (Table 6).

3.7. Highly cited papers

There are 19 Saudi Arabian papers, which have received 50 or more citations since their publication till 22 February

Table 5 Productivity and Citation Impact of Top 15 Saudi Arabian Authors in Pharmaceutical Science, 2001–10.

S. No	Name	Address	TP	TC	ACPP	H-Index	ICP	% ICP
1.	H.Y. Aboul-Enein	King Saud Univ, Coll of Pharm	85	325	3.82	16	57	67.06
2.	A. Al-Shabanah	King Saud Univ, Coll of Pharm	43	147	3.42	14	1	2.33
3.	I.A. Alsarra	King Saud Univ, Coll of Pharm	36	76	2.11	8	5	13.89
4.	F.F.Belal	King Saud Univ, Coll of Pharm	30	84	2.80	11	9	30.00
5	A.A. Al-Majed	King Saud Univ, Coll of Pharm	27	123	4.56	12	0	0.00
6.	J.S. Mossa	King Saud Univ, Coll of Pharm	26	75	2.88	7	3	11.54
7.	M.A. Al-Omar	King Saud Univ, Coll of Pharm	26	81	3.12	8	8	30.77
8.	B.H. Ali	Al Qaseem Univ, Dept Vet Med	23	142	6.17	11	6	26.09
9.	H.I. El-Subbagh	King Saud Univ, Coll of Pharm	23	86	3.74	8	7	30.43
10.	F.K. Alanazi	King Saud Univ, Coll of Pharm	19	50	2.63	5	3	15.79
11.	H.A. Khan	Armed Forces Hosp, Riyadh	18	33	1.83	4	1	5.56
12.	N.S. Barakat	King Saud Univ, Coll of Pharm	17	55	3.24	6	1	5.88
13.	F.S. El-Feraly	King Saud Univ, Coll of Pharm	16	67	4.19	9	15	93.75
14.	S.A. Rostom	King Abdulaziz Univ, Deptt Pharm Chem	15	92	6.13	9	7	46.67
15.	A.A.M. Abdel-Aziz	King Saud Univ, Coll of Pharm	15	112	7.47	8	11	73.33
		Total	419	1548	3.69	9.06	134	31.98
		Total Output of Saudi Arabia	1386					
		Share of Top 15 Authors in Total Output of Saudi Arabia	30.23					

Table 6 Profile of top 15 Journals where Saudi Arabian scientists have published in pharmaceutical science, 2001–10.

S. No.	Name of the journal	Number of papers			IF 2010
		2001–05	2006–10	2001–10	
1	Saudi Pharmaceutical Journal	76	69	145	0.13
2	Biosciences Biotechnology Research Asia	6	37	43	
3	Journal of Pharmaceutical and Biomedical Analysis	30	12	42	2.73
4	European Journal of Medicinal Chemistry	3	34	37	3.19
5	Archiv Der Pharmazie	17	15	32	
6	Farmaco	28	0	28	
7	Scientia Pharmaceutica	14	13	27	
8	International Journal of Pharmacology	0	27	27	
9	Biomedical Chromatography	17	10	27	1.54
10	Phytotherapy Research	15	7	22	
11	Pharmacological Research	20	2	22	3.61
12	Food and Chemical Toxicology	4	16	20	2.602
13	Pharmazie	16	4	20	0.869
14	Journal of Medicinal Plants Research	0	17	17	0.879
15	Journal of Ethnopharmacology	12	3	15	2.466
	Total	258	266	524	258
	Total Output of Saudi Arabia	567	819	1386	567
	Share of top 15 journals in Saudi Arabia Total Output	45.50	32.48	37.81	45.50

2012 (Table 7). These are referred here as high cited papers. Of the 19 high cited papers, 10 have appeared as articles and 9 as reviews. Of the 19 high cited papers, 5 were international (4 bilateral and 1 multilateral) collaborative. Of the 19 high cited papers, 1 paper falls in the citation range of 201–227, 2 papers fall in the citation range of 100–199 and 16 papers fall in the citation range of 50–99. These 19 high cited papers have received 1566 citations, with an average of 82.42 citations per paper and the citation range of these papers varies from 50 to 227. These 19 high cited papers involve 7 Saudi Arabian organizations. Among them, the largest number of papers (6) is contributed by King Saud University, College of Pharmacy, followed by King Faisal Specialist Hosp & Research Center (5 papers), King Abdul-Aziz University (3 papers), King Saud University, Department of Veterinary Medicine (2 papers), King Faisal

University, College of Medicine (1 paper), Armed Forces Hospital, Department of Internal Medicine, Riyadh (1 paper) and Taibah University, Department of Clinical Biochemistry (1 paper).

These 19 high cited papers have appeared in 15 journals. Among them, the largest number of papers (2) each of which appeared in Alimentary Pharmacology and Therapeutics, Current Drug Metabolism, European Journal of Medicinal Chemistry and Pharmacological Research and 1 paper each in Bioorganic and Medicinal Chemistry, Chirality, European Journal of Pharmaceutical Sciences, European Journal of Pharmaceutics and Biopharmaceutics, Food and Chemical Toxicology, International Journal of Pharmaceutics, Journal of Ethnopharmacology, Journal of Pharmaceutical and Biomedical Analysis, Medicinal Research Reviews, Phytotherapy Research and Tetrahedron.

Table 7 List of highly cited papers by Saudi Arabian authors in pharmaceutical science, 2001–10.

Authors	Title	Source	No. of Citations
Ali B.H., Blunden G.	Pharmacological and toxicological properties of Nigella sativa	Phytotherapy Research 2003, 17(4), 299–305	227
Ghanem A.	Trends in lipase-catalyzed asymmetric access to enantiomerically pure/enriched compounds	Tetrahedron 2007, 63(8), 1721–54	134
Al-Ghamdi M.S.	The anti-inflammatory, analgesic and antipyretic activity of Nigella sativa	Journal of Ethnopharmacology 2001, 76(1), 45–48	122
Khuroo M.S., Khuroo N.S., Farahat K.L.C., Khuroo Y.S., Sofi A.A., Dahab S.T.	Meta-analysis: Endoscopic variceal ligation for primary prophylaxis of esophageal variceal bleeding	Alimentary Pharmacology and Therapeutics 2005, 21(4), 347–361	93
Ghanem A., Aboul-Enein H.Y.	Application of lipases in kinetic resolution of racemates	Chirality 2005, 17(1), 1–15	89
Okarvi S.M.	Peptide-Based Radiopharmaceuticals: Future Tools for Diagnostic Imaging of Cancers and Other Diseases	Medicinal Research Reviews 2004, 24(3), 357–97	87
El-Kamel A.H.	In vitro and in vivo evaluation of Pluronic F127-based ocular delivery system for timolol maleate	International Journal of Pharmaceutics 2002, 241(1), 47–55	86
Saad S.Y., Najjar T.A., Al-Rikabi A.C.	The preventive role of deferoxamine against acute doxorubicin-induced cardiac, renal and hepatic toxicity in rats	Pharmacological Research 2001, 43(3), 211–18	78
Rostom S.A.F., Shalaby M.A., El-Demellawy M.A.	Polysubstituted pyrazoles, part 5.1. Synthesis of new 1-(4-chlorophenyl)-4-hydroxy-1H-pyrazole-3-carboxylic acid hydrazide analogs and some derived ring systems. A novel class of potential antitumor and anti-HCV agents	European Journal of Medicinal Chemistry 12 Nov 2003, 38, 959–74	67
Belal F., Al-Zaagi I.A., Gadkariem E.A., Abounassif M.A.	A stability-indicating LC method for the simultaneous determination of ramipril and hydrochlorothiazide in dosage forms	Journal of Pharmaceutical and Biomedical Analysis 2001, 24(3), 335–42	67
Sanai F.M., Bzeizi K.I.	Systematic review: Tuberculous peritonitis - Presenting features, diagnostic strategies and treatment	Alimentary Pharmacology and Therapeutics 2005, 22(8), 685–700	65
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Kadi A.A., El-Brollosy N.R., Al-Deeb O.A., Habib E.E., Ibrahim T.M., El-Emam A.A.	Synthesis, antimicrobial, and anti-inflammatory activities of novel 2-(1-adamantyl)-5-substituted-1,3,4-oxadiazoles and 2-(1-adamantylamino)-5-substituted-1,3,4-thiadiazoles	European Journal of Medicinal Chemistry 2007, 42(2), 235–42	56
Ali B.H.	Agents ameliorating or augmenting experimental gentamicin nephrotoxicity: Some recent research	Food and Chemical Toxicology 2003, 41(11), 1447–52	56
Al-Majed A.A., Mostafa A.M., Al-Rikabi A.C., Al-Shabanah O.A.	Protective effects of oral arabic gum administration on gentamicin-induced nephrotoxicity in rats	Pharmacological Research 2002, 46(5), 445–451	55
Sheweita S.A., Tilmisany A.M., Al-Sawaf H.	Mechanisms of male infertility: Role of antioxidants	Current Drug Metabolism 2005, 6(5), 495–501	50
Alsarra I.A., Bosela A.A., Ahmed S.M., Mahrous G.M.	Proniosomes as a drug carrier for transdermal delivery of ketorolac	European Journal of Pharmaceutics and Biopharmaceutics 2005, 59(3), 485–90	50

4. Summary and results

Saudi Arabia in pharmaceutical research has produced 1386 papers during 2001–10, increasing from 111 papers in 2001 to 301 papers in 2010 and witnessing an annual productivity of 138.6 and annual average growth rate of 14.21%. Its citation impact was 3.36 during 2001–10, which decreased from 3.38 to 3.35 from 2001–05 to 2006–10. The share of its interna-

tional collaborating papers output, constitute 40.55% of its output, increasing from 32.45% during 2001–05 to 46.15% during 2006–10. The largest number of international collaborative papers (with 43.95% share) of Saudi Arabia comes with Egypt, followed by USA (15.66% share), India (12.46% share), U.K (7.12% share), Germany and Japan (3.56% share each), Canada (3.38% share), Sudan (2.85% share), etc. The maximum focus of pharmaceutical research was on cancer (with 149 papers), followed by heart diseases (104 papers), diabetes (61 papers), respiratory infection (26 papers), blood disorders (22), tuberculosis (15), depression (14 papers), HIV/AIDS (10), diarrhea (10), epilepsy (10 papers), pneumonia (9), malaria (9), hepatitis (9 papers), etc. In terms of pharmacological activity, the largest research was focused on enzyme activity (with 125 papers), followed by anti-oxidant activity (87 papers), anti-neoplastic activity (70 papers), anti-inflammatory activity (54 papers), anti-microbial activity (40 papers), anti-bacterial activity (27 papers), anti-fungal activity (22 papers), analgesic activity (20 papers), anti-viral activity (17 papers), etc. The top 15 most productive Saudi Arabian organizations involved in pharmaceutical research together have published 1336 during 2001–10, accounting for 96.39% share in the cumulative publications output of Saudi Arabia, with an average of 89.6 papers per organizations. The average citation per paper and average h-index registered by the total papers of these 15 Saudi Arabian organizations were 3.41 (varying from 1 to 5.21) and 10.60 (varying from 4 to 27). The 15 most productive authors have together contributed a total of 419 papers (varying from 15 to 85), constituting 30.23% share of the total output of Saudi Arabia and registering an average productivity per author of 27.93. The average citation per paper and average h-index registered by the total papers of these 15 Saudi Arabian authors were 3.69 (varying from 1.83 to 7.47) and 9.06 (varying from 4 to 16). The top 15 journals where Saudi Arabian scientists have published together contributed 524 papers in pharmaceutical science, which accounted for 37.81% of the total output of Saudi Arabia during 2001–10, decreasing from 45.50% during 2001–05 to 32.48% during 2006–10. There are 19 Saudi Arabian papers, which have received 50 or more citations since their publication. These 19 high cited papers have received an average of 82.42 citations per paper and the citation range of these papers varies from 50 to 227. These 19 high cited papers involve 7 Saudi Arabian organizations and have appeared in 15 journals.

5. Conclusion

There is a need to improve the number of publications in order to measure Saudi Arabia's research in pharmaceutical sciences. As most of the universities and major organizations are speeding up in a setting research atmosphere all over country it is obvious, based on fact of Globalization of Research and education, Saudi Arabia will emerge as one of the productive countries in terms of pharmaceutical research. Rigorous efforts are still necessary with respect to research productivity, international collaborations, multi cultured research environ-

ment, cutting edge drug discovery and quality research. It is now clear, that the number of research output in terms of publications has seen a tremendous growth in last 2–3 years. We foresee that Saudi Arabia will become the most productive country in the near future.

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