Research contributions of J.S. Yadav to chemical sciences: a scientometric study

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ABSTRACT

This paper highlights quantitatively the growth and development of chemical science research by J.S.Yadav during the period from 1986-2009. During this period he has published 722 papers (702 research articles) in various domains. The data used was from Thomson/ISI Web of Science. This study attempts to evaluate the publications of J.S. Yadav in relation to his contribution to the knowledge domain of chemical science and his role for the advancement of chemical science in India and elsewhere in a span of about two and half decades. His papers have been scattered in 56 high impact factor scientific journals. The percentage of collaborative work (99.7) was very high. His highest degree of collaboration 0.1925, was found during 2002-2003.The h index of 41 after 24 years of scientific activity is a clear indication of his consistent publication productivity behaviour.

Keywords: Scientometrics; Bibliometrics; Citation studies; Publication productivity; h-index; Organic chemistry; Role model scientists

INTRODUCTION

Scientific publications seems to have provided the best available basis for measuring the outputs of individual scientist as there is good correlation between the eminence of scientists and their sustained research publications (Price 1986). One of the first few writers to suggest scientific publication as a measure of research productivity was William Shockley, a Nobel laureate who was interested in measuring productivity among individuals within a group by analyzing their publication (Bruan 1999). From scientometric analysis, it is possible to develop to a model on the performance of a role model scientist of a country who has direct bearing on the identification of promising scientists and human resource development in developing countries (Kadameni, Kalyane and Kumar 2001). Individual scientists including the Nobel laureates have becoming the focus of scientometric studies for quite sometime. An ever-growing stress has been laid on scientometrists to publish data on individual scientists rather than gross statistical "macro" data (Schubert and Glanzel 1992).

A good number of scientometric studies have been carried out on individual scientists from diverse subject backgrounds and disciplines. Scientometric analysis have been carried out

on Nobel Laureates Leland H.Hartwell, a renowned molecular biologist (Angadi et al 2004); Ahmed Hassan Zewail, a renowned chemist (Kademani, Kalyane and Vijay 2001); Dorothy Crowfoot Hodgkin, a renowned crystallographer (Kademani, Kalyane and Suresh 1999); Pierre-Gilles de Gennes, a renowned physicist (Kalyane and Sen 1996); and Harold W. Kroto, another renowned chemist (Kademani, Kalyane and Kumar 2002). Scientometric studies have also been carried out on eminent personalities such as Peter John Wyllie, a renowned physicist (Sangam et al 2006) and Nayana Nanda Borthakur, a renowned biometeorologist (Tilak, Dipak and Sen 2010). This study is an attempt to draw a scientometric portrait of Dr. J. S. Yadav, an eminent chemical scientist from India.

Dr. J. S. Yadav (Jhillu Singh Yadav) was born on the 4th August, 1950 in Azamgarh District of Uttar Pradesh, India. He obtained both his postgraduate degrees in Organic Chemistry in India, a masters' degree in 1972 and a doctoral degree in 1976. He pursued his post doctoral studies at Rice University, Houston, Texas and UW (University of Wisconsin), Madison, USA. He returned to India and joined in the Council of Scientific & Industrial Research (CSIR) service in 1981 at the National Chemical Laboratory (NCL) Pune. Subsequently he moved to Indian Institute of Chemical Technology (IICT), Hyderabad in 1986. In 1989, he was promoted as the head of the department, heading the Organic Chemistry Division (natural products and synthetic organic chemistry), the largest research group at IICT. Later in 2003, J.S. Yadav was appointed as the director of the Indian Institute of Chemical Technology (IICT), Hyderabad, where he led 1100 dedicated staff, including 250 research scientists in research and development divisions. In a span of two and half decades of research career, J. S. Yadav has been able to successfully carry out extensive basic and applied research investigations in the synthesis of complex natural products of biological relevance. He is a specialist in asymmetric synthesis to create new chiral centres in complex organic molecules and utilize them effectively in synthesis of many bioactive molecules such as hydroxy fatty acid, discodermalice, rifamycin, scytophycin, calcimycin, artemisin and taxol. His research group has successfully developed cost effective technologies for special chemicals such as Diltiazem, Ondaseyron, Pyrazinamide, Ketotifen, Mefloquin and Tamoxifen, which have been very well received by the Indian and international drug industries. The world leading supplier in the chemical industry such as Smithkline Beecham (SB), Dupont, FMC and Ranbaxy, Lupin and Dabur have entered into medium term contract research agreement with Yadav's research teams. Yadav's expertise and skills in organic chemistry are outstanding and this is reflected in him being members of prestigious scientific bodies such as Department of Science and Technology, Technical Advisory Board (TAB) and being the national representative of International Union for Pure and Applied Chemistry (IUPAC). He received many academic and industrial awards – the Shanti Swarup Bhatnagar Award (1991), Vasvik Award in Chemical Sciences & Technology (1999), Ranbaxy Research Award in Pharmaceutical Sciences (2000), Prof. Swaminathan 60th Birthday Commemoration Lecture Award (2002), Vigyan Ratna, Vigyan Gaurav Awards of Council for Science and Technology, Uttar Pradesh (2003 and 2004), Goyal Award 2003, DOST Prof S K Sharma Medal and Chemcon Distinguished Speaker (2006), Central Drug Research Institute (CDRI) oration award (2006), CHEMTECH award for Outstanding Achievement in R&D/Innovation Institutions in Pharma + Biotech (2007), Laureate of the 22nd Khwarizmi International Award (2008), Banaras Hindu University (BHU), Varanasi, Distinguished Alumnus Award (2009). He was also appointed as a fellow for the following: JC Bose (Department of Science & Technolgy, Government of India) in 2005, Third World Academy of Sciences for the developing world (FTWAS) in 2006, National Academy of Sciences (1993), Indian National Science Academy (1998), and the Andhra Pradesh Academy of Sciences (2001). He has to his credit over 750 research publications in various reputable national and international journals. He has also 20 International Patents and 27

Indian Patents to his credit. J.S. Yadav is sought after as a research consultant for doctoral and postdoctoral programmes and more than 109 research scholars have obtained their academic degrees under his guidance and supervision. He is indeed a recognized scholar and expert in chemical sciences in most of the academic institutions throughout the country.

OBJECTIVES AND METHOD

J.S. Yadav has been taken as a case study for the present scientometric analysis. The study highlights J.S. Yadav's:
- yearwise publications and productivity
- authorship pattern
- prominent collaboration
- use of channels of communication
- citations received and h-index
- documentation of keywords from titles of papers

A total of 722 research papers by J.S. Yadav published from 1986 to May, 2009 was obtained from the Web of Science (WOS) database. The data was analysed as per the requirements of the study. The bibliographic fields were analysed by normal count procedure for domains, authorships and journal names, similar with the method used in Kademani et al (2002).

RESULTS AND DISCUSSION

Publication and Productivity

J.S. Yadav published 722 research articles in the following domains: Organic chemistry, Multidisciplinary chemistry, Physical chemistry, Biochemistry and Molecular biology, Inorganic and nuclear chemistry, Applied chemistry, Plant science, Biotechnology and Applied microbiology and Crystallography and other multi discipline areas of chemistry. Around 570 of his articles fall under the Organic Chemistry category. Table 1 provides the information about the number of papers published each year in chronological period. It is observed that during the last decade (1999-2008) J.S. Yadav has published 593 papers with an average of 60 papers per year. His highest productivity was in 2007 with an output of 94 publications, followed by 93 in 2008.

The 722 publication records were further categorized based on document types (Table 2) of which 702 papers are journal articles followed by correction, note, and proceedings paper (4 each), letter (3), meeting abstract (2), reviews (2) and biographical item (1). This indicates that J.S. Yadav has spent more time on creation of new knowledge through research publications and his contemporary reviews are limited.

Table 1: Year wise Distribution of research papers

Publication Year	No. of Records	Publication Year	No. of Records
1986	2	1998	23
1987	5	1999	25
1988	7	2000	33
1989	12	2001	56
1990	12	2002	75
1991	2	2003	64
1992	5	2004	57
1993	9	2005	52
1994	8	2006	44
1995	9	2007	94
1996	5	2008	93
1997	12	2009*	18

* Data incomplete for the year 2009

Table 2: Types of different Publications during 1986-2009

Document Type	Records
Article (journal)	702
Correction	4
Note	4
Proceedings Paper	4
Letter	3
Meeting Abstract	2
Review	2
Biographical Item	1
	722

Table 3 presents J.S. Yadav's publication productivity in chronological order from 1986 to May 2009 comprising 2 single-authored and 720 multi-authored papers. The multi-authored papers include 53 (7.3%) two-authored works, 173 (24.02%) three-authored, 296 (41.1%) four-authored, 131 (18.1%) five-authored, and 67 (9.3%) papers belong to more than five authored. Figure 1a and 1b presents Yadav's yearwise authorship pattern for 1986-1997 and 1998-2009 respectively.

Table 3: Publication Productivity of J.S. Yadav in Chronological Order

S.No.	Year	Single and multi-authored papers						MT	TP	AA
		1	2	3	4	5	>5			
1	1986	-	-	1	1	-	-	2	2	36
2	1987	-	-	3	2	-	-	5	5	37
3	1988	-	2	2	2	1	-	7	7	38
4	1989	-	3	7	2	-	-	12	12	39
5	1990	-	4	5	3	-	-	12	12	40
6	1991	-	1	-	1	-	-	2	2	41
7	1992	-	-	5	-	-	-	5	5	42
8	1993	1	1	4	2	1	-	8	9	43
9	1994	-	1	5	2	-	-	8	8	44
10	1995	-	-	3	5	1	-	9	9	45
11	1996	-	1	1	2	1	-	5	5	46
12	1997	-	3	5	4	-	-	12	12	47
13	1998	-	3	6	14	-	-	23	23	48
14	1999	-	1	7	15	2	-	25	25	49
15	2000	-	6	7	19	1	-	33	33	50
16	2001	-	5	18	19	11	3	56	56	51
17	2002	-	9	14	34	11	7	75	75	52
18	2003	-	4	23	22	12	3	64	64	53
19	2004	-	4	11	18	17	7	57	57	54
20	2005	1	-	6	22	14	9	51	52	55
21	2006	-	-	11	13	9	11	44	44	56
22	2007	-	3	16	44	20	11	94	94	57
23	2008	-	1	11	41	26	14	93	93	58
24	2009*	-	1	2	9	4	2	18	18	59
	Total:	2	53	173	296	131	67	720	722	

* Data incomplete for the year 2009
MT = Total of multi-authored publications.
TP = Total Publications.
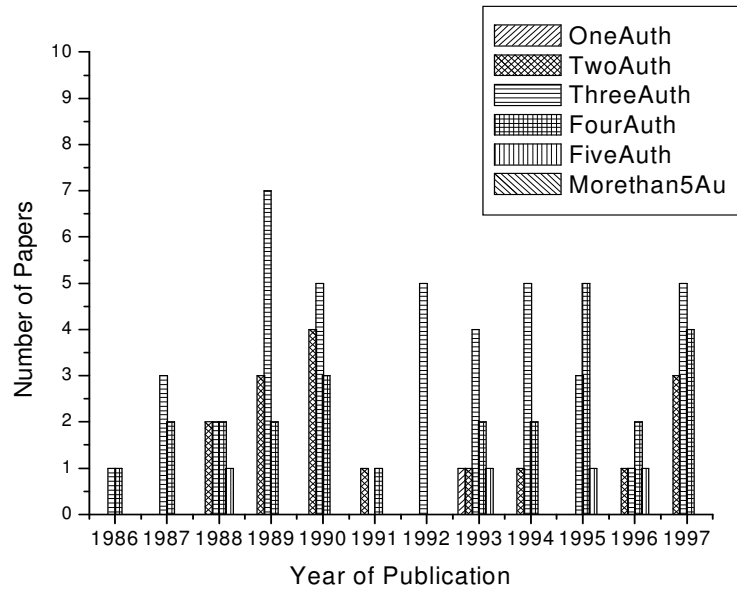AA = Biological Age of the Author.
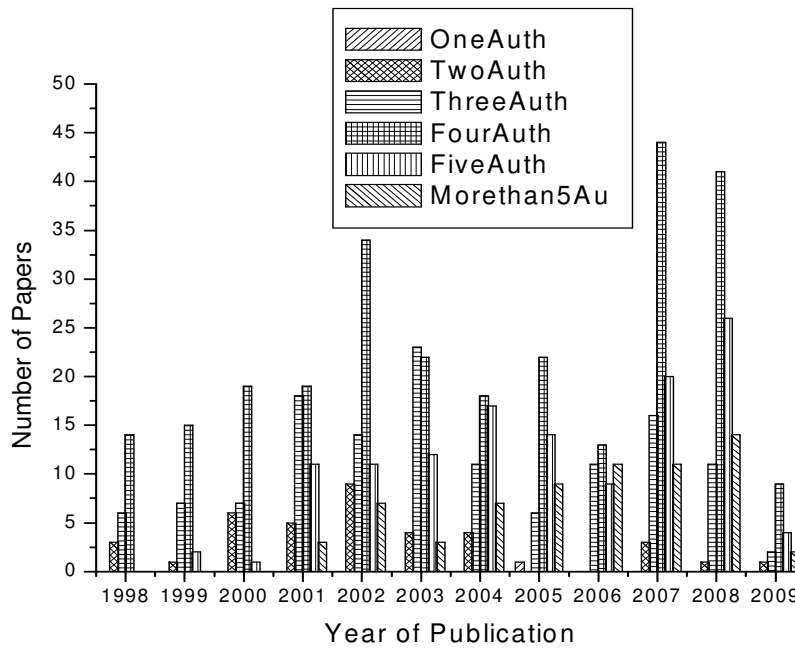
Figure 1a: Yearwise authorship pattern (1986-1997)

Figure 1b: Yearwise authorship pattern (1998-2009)

Collaboratorship

Collaboration is an intense form of interaction that allows for effective communication as well as the sharing of competence and other resources. Collaboration can also be mentioned as a novel process where two or more researchers work together in an intersection of common goals that are creative in nature by sharing knowledge, learning and building consensus. It can bring better results, recognition when facing competition for finite resources. In order to measure the collaborative research pattern, a simple indicator called Collaboration Coefficient (Subramanyam 1983) which refers to the number of collaborative papers divided by the total number of papers in a particular period, is used. In this paper Collaboration Coefficient (CC) has been calculated for two consecutive progressive years from 1986 onwards. The same has been reported to the corresponding age of the author. Figure 2 gives the graphical presentation of Yadav's CC. The highest CC (0.1925) was found during the year 2002-2003 which indicates J.S. Yadav's active collaborative research during these years at the age of 52-53. Table 4 details this finding.

Researchers and their authorships in collaboration with J.S. Yadav in descending order of their association are documented.Yadav has collaborated with a total of 408 researchers from 1998 to May 2009, and Table 5 shows only those authors who have collaborated in more than 10 papers. Most active researchers having number of publications with J.S. Yadav were BVS Reddy (364; 50.4%), published during 1997–2009, followed by G Sabitha (100; 13.4%) and AR Prasad (47; 6.5%). The remaining authors have collaborated in less than 5% of his publications.
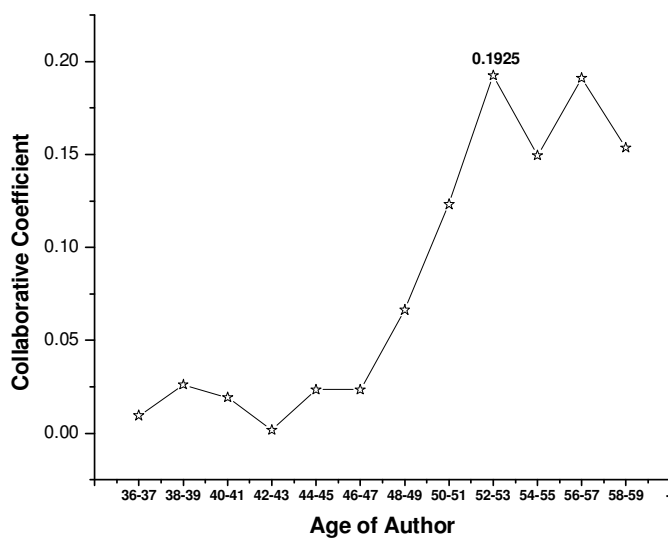

Figure 2 : Degree of Collaboration in Research

Table 4: Collaborative Coefficient (CC) with Age

Year	Age	CC
1986-1987	36-37	0.0096
1988-1989	38-39	0.0263
1990-1991	40-41	0.0193
1992-1993	42-43	0.0018
1994-1995	44-45	0.0235
1996-1997	46-47	0.0235
1998-1999	48-49	0.0664
2000-2001	50-51	0.1232
2002-2003	52-53	0.1925
2004-2005	54-55	0.1495
2006-2007	56-57	0.1911
2008-2009	58-59	0.1537

Table 5: Authorship Credits to Collaborators with J.S. Yadav

S.No	Author	Period of Association	TY	No. of Authorships	Percentage
1	Yadav JS	1986-2009	24	722	100.0
2	Reddy BVS	1997-2009	13	364	50.4
3	Sabitha G	1998-2009	12	100	13.9
4	Prasad AR	1998-2009	12	47	6.5
5	Kunwar AC	2001-2009	9	33	4.6
6	Kumar HMS	1993-2007	15	28	3.9
7	Narsaiah AV	2003-2008	6	28	3.9
8	Gupta MK	2004-2009	6	27	3.7
9	Meshram HM	1997-2009	13	27	3.7
10	Nagaiah K	2001-2008	8	27	3.7
11	Srihari P	2001-2009	9	26	3.6
12	Basak AK	2003-2008	6	23	3.2
13	Rao RS	2001-2008	8	22	3
14	Chandrasekhar S	1989-2008	20	20	2.8
15	Kumar GGKSN	2007-2009	3	20	2.8
16	Reddy CS	2001-2009	9	20	2.8
17	Ramalingam T	2000-2002	3	18	2.5
18	Rao AB	1994-2008	15	18	2.5
19	Rao AVR	1986-2008	23	18	2.5
20	Reddy KB	2001-2008	8	18	2.5
21	Reddy GS	1997-2003	7	17	2.4
22	Srinivas R	2000-2009	10	17	2.4
23	Reddy EV	2000-2008	9	16	2.2
24	Reddy GSKK	2000-2007	8	16	2.2
25	Reddy MS	2002-2008	7	16	2.2
26	Baishya G	2002-2008	7	15	2.1

27	Satheesh G	2002-2009	8	14	1.9
28	Swamy T	2003-2008	6	14	1.9
29	Babu RS	1998-2005	8	13	1.8
30	Eeshwaraiah B	2003-2009	7	12	1.7
31	Rao PP	2004-2008	5	12	1.7
32	Reddy PN	2003-2007	5	12	1.7
33	Anjaneyulu S	1998-2007	10	11	1.5
34	Krishna AD	2003-2008	6	11	1.5
35	Murty MSR	2001-2008	8	11	1.5
36	Nanda S	1999-2003	5	11	1.5
37	Sadashiv K	2002-2007	6	11	1.5
38	Abraham S	1999-2002	4	10	1.4
39	Gayathri KU	2002-2009	8	10	1.4
40	Kondaji G	2002-2008	7	10	1.4
41	Reddy JSS	2002-2008	7	10	1.4
42	Reddy KS	2001-2006	6	10	1.4
43	Srinivas D	1992-2000	9	10	1.4
44	Vishnumurthy P	2003-2008	6	10	1.4

TY= Total year of association

For any given researcher authorship status changes from paper to paper. Table 6 indicates that J.S. Yadav has been the first and primary author in 511 (70.7%) papers, second author in 12(1.66%) papers, third author in 41 (5.67%) papers, fourth author in 107 (14.81%) papers, fifth author in 36 (4.98%) papers, sixth and seventh author in 13 (1.8%) and 2 (0.02%) papers respectively. His authorship status indicates his leadership qualities in guiding his team towards innovative research. The maximum number of papers in which J.S. Yadav was the first author clearly indicates his primary contribution or original idea and discovery in this scientific field. The remaining authorship status indicates his guidance to the collaborative authors of his research team.

Table 6: Collaboration Pattern

Sl.No	Year	1 Aut	2 Aut	3 Aut	4 Aut	5 Aut	6 Aut	7 Aut
1	1986	-	1	-	1	-	-	-
2	1987	2	-	1	2	-	-	-
3	1988	5	-	1	-	1	-	-
4	1989	9	2	1	-	-	-	-
5	1990	11	1	-	-	-	-	-
6	1991	1	1	-	-	-	-	-
7	1992	5	-	-	-	-	-	-
8	1993	6	-	-	2	1	-	-
9	1994	5	1	-	2	-	-	-
10	1995	3	-	2	4	-	-	-
11	1996	2	-	1	1	1	-	-
12	1997	8	-	2	2	-	-	-
13	1998	10	1	2	10	-	-	-

14	1999	3	-	5	15	2	-	-
15	2000	22	-	1	9	1	-	-
16	2001	47	1	2	3	3	-	-
17	2002	62	1	4	6	1	1	-
18	2003	49	2	1	8	4	-	-
19	2004	50	-	-	3	4	-	-
20	2005	35	-	1	8	4	3	1
21	2006	25	-	3	7	6	2	1
22	2007	73	-	8	8	1	4	-
23	2008	64	1	6	15	5	2	-
24	2009*	14	-	-	1	2	1	-
Total		511	12	41	107	36	13	2

Channels of Communication

The distribution of J.S. Yadav's 722 publications were spread over 56 journals. The channelwise scattering of publications is provided in Table 7. The top ranking journals with a number of his publications are: *Tetrahedron Letters* (244)*, Synthesis-Stuttgart* (84)*, Synthetic Communication* (64)*, Synlett* (63), *Chemistry Letters* (38)*, Tetrahedron* (34) and *Journal of Molecular Catalysis A-Chemical* (26). Seventy six percent of his research papers are published in this top ranking journals having high impact factor ranging from (2.66 - 35.957). Journals such as Tetrahedron letters have more visibility and accessibility to most organic chemists, which reflects J.S. Yadav's interest in making his research findings available to a wider community of organic chemists. Figure 3 indicates the frequency and cumulative frequency of distribution of his research papers in 56 journals.

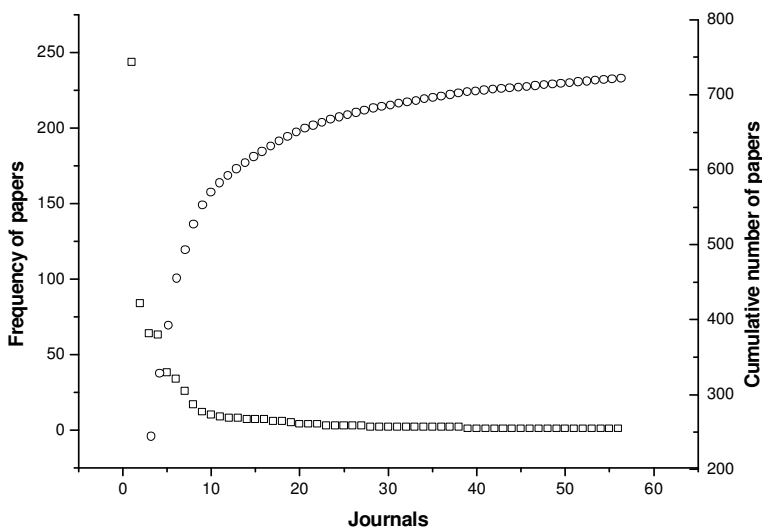Figure 3: Frequency and cumulative frequency of distribution

Table 7 : Scattering of research papers in various journals

Journal	No. of Papers	Cumulative	FPY-LPY	TY
Tetrahedron Letters	244	244	1986-2009	24
Synthesis-Stuttgart	84	328	1999-2009	11
Synthetic Communications	64	392	1987-2009	23
Synlett	63	455	1998-2009	12
Chemistry Letters	38	493	1997-2008	12
Tetrahedron	34	527	1988-2009	22
Journal of Molecular Catalysis A-Chemical	26	553	2004-2008	5
Tetrahedron-Asymmetry	17	570	1997-2009	13
New Journal of Chemistry	12	582	1999-2004	6
Advanced Synthesis & Catalysis	10	592	2001-2005	5
Indian Journal of Chemistry Section B-Organic Chemistry Including Medicinal Chemistry	9	601	1986-2006	21
Journal of Chemical Research-S	8	609	2000-2003	4
Journal of Organic Chemistry	8	617	1992-2008	17
Catalysis Communications	7	624	2004-2008	5
Green Chemistry	7	631	1999-2003	5
Letters in Organic Chemistry	7	638	2005-2009	5
Journal of the Chemical Society-Perkin Transactions 1	6	644	1990-2002	13
Phytochemistry	6	650	1993-1995	3
Organic Letters	5	655	1999-2009	11
Arkivoc	4	659	2003-2006	4
Helvetica Chimica Acta	4	663	2005-2008	4
Pure and Applied Chemistry	4	667	1990-2001	12
Canadian Journal of Chemistry-Revue Canadienne De Chimie	3	670	2007-2008	2
Carbohydrate Research	3	673	1987-2001	15
Current Science	3	676	1988-2008	21
European Journal of Organic Chemistry	3	679	2003-2004	2
Journal of The Chemical Society-Chemical Communications	3	682	2002-2004	3
Abstracts of Papers of the American Chemical Society	2	684	2002-2004	3
Acta Crystallographica Section C-Crystal Structure Communications	2	686	1995-1996	2
Angewandte Chemie-International Edition	2	688	2003-2007	5
Applied Biochemistry and Biotechnology	2	690	2002-2008	7
Bioorganic & Medicinal Chemistry Letters	2	692	2005-2005	1
Chemical Communications	2	694	2004-2007	4
Chinese Chemical Letters	2	696	2008-2008	1
Heteroatom Chemistry	2	698	2008-2008	1
Heterocyclic Communications	2	700	2000-2001	2
Journal of Scientific & Industrial Research	2	702	1989-1990	2
Monatshefte fur Chemie	2	704	2008-2008	1
18 Journals with one paper each	18	722	1989-2008	20

FPY = First paper year, LPY = Last paper year, TY = Total year,

Citation Analysis and H- Index

An attempt was made to study the citation received by J.S. Yadav and determine his *h*-index. The 722 publications have received 8,826 citations during the period of study with an average citations of 12.22 per paper 12.22 and average citations of 420.28 per year. Figures 4 and 5 illustrate the published papers and citations of the same in year wise pattern. This shows that these publications made considerable influence in the growth of science in organic chemistry in the world.

The **h-index** is an index that attempts to measure both the scientific productivity and the apparent scientific impact of a scientist. The index is based on the set of the scientist's most cited papers and the number of citations that they have received in other people's publications. The index can also be applied to the productivity and impact of a group of scientists (Hirsch 2005). According Hirsch (2005)

i.   A value of an *h* index of 20 after 20 years of scientific activity, characterizes a successful scientist.
ii. A value of an *h* index of 40 after 20 years of scientific activity), characterizes outstanding scientists, likely to be found only at the top universities or major research laboratories.
iii. A value of an *h* index of 60 after 20 years, or 90 after 30 years, characterizes truly unique individuals.

J.S. Yadav has an h-index of 41. This value obtained after 24 years of scientific activity characterizes that he is an outstanding scientist in the field of chemical science.
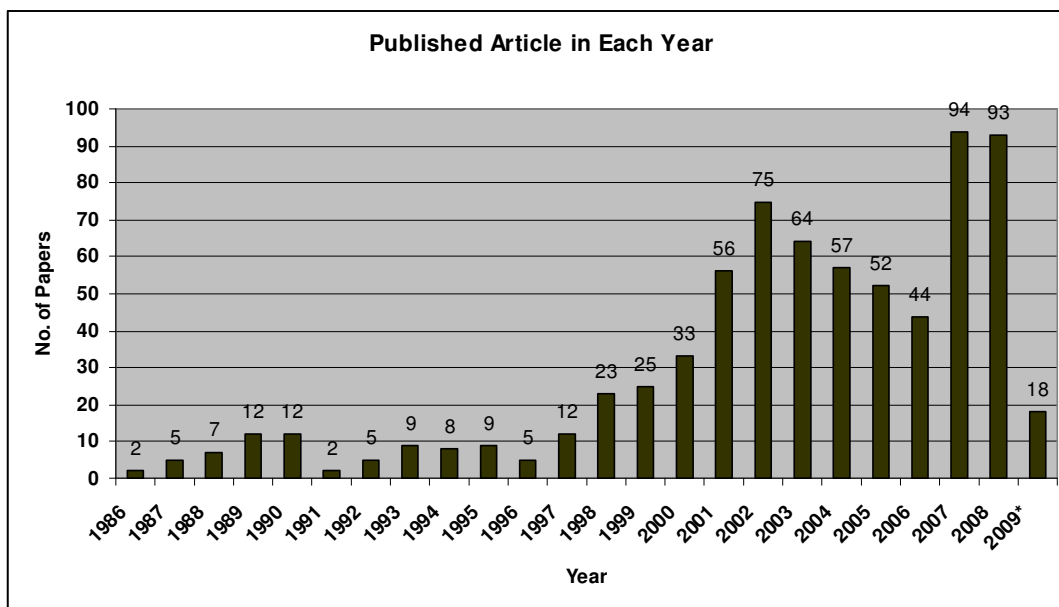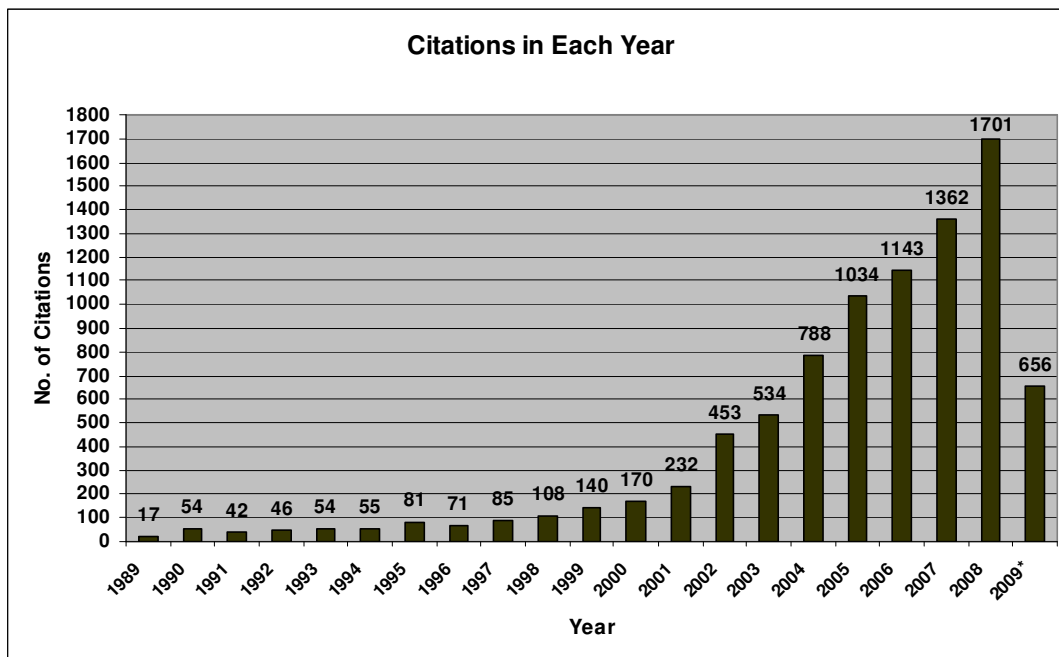

Figure 4: Yearwise published Papers

Citations in Each Year

Figure 5: Yearwise received Citations

Keyword Tomography

Keyword analysis is useful for research impact assessment. Titles of publications convey precisely the thought contents of the papers. The potency of information concentrated on the titles of the papers is more than the rest of the sections of the papers. Therefore if a word occurs more frequently than expected it to occur, then it reflects the emphasis given by the author about the domain of his research. These important words called 'keywords' are one of the best indicators to understand and to grasp instantaneously the thought content of the papers, methodologies used and areas of research addressed to (Angadi et al 2006). The keyword frequencies appeared in the titles of the papers are provided in Table 8.

Table 8: Keyword Frequencies from the Titles of Publications by J.S. Yadav
during 1986-2009

Keywords	Frequency	Keywords	Records
Synthesis	429	Aldehydes	25
Stereoselective	76	Ethers	22
Alcohols	55	Hydroxy	22
Ionic	44	Triflate	21
Indium	41	Alder	20
Microwave	38	Amines	20
Chloride	37	Aryl	20
Prins	33	Diels	20
Ketones	31	Epoxides	20

BRADFORD'S-ZIPF'S LAW

Bradford's law is one of several statistical expressions that try to describe the workings of science by mathematical means. It describes how the literature on a particular subject is scattered or distributed in various journals. If journals are ranked by the number of articles they contain on a given topic, they can be divided into a central nucleus of the most important journals and a series of zones each containing the same number of articles as the nucleus (but each containing many more journals). In addition, Zipf's Law describes the frequency distribution of words in a given text, with familiar words being used many times and many words being used only once. Bradford's and Zipf's laws have been shown to be mathematically identical and so the distribution is often referred to as the Bradford-Zipf distribution (Sangam et al 2006)

J.S. Yadav has contributed 722 papers spread over in 56 reputable journals during the period for this study. To test whether or not his contributions follow Bradford's law of scattering, J.S. Yadav's works were analysed based on average number of articles per journal in the first three "scatter zones". One journal accounted for 244 papers; the next four journals produced 249 papers, and the next 51 journals produced 229 papers. The numbers of the three zones of journals to produce nearly equal number of articles is roughly in proportion to 1:4:16 or $4^{0:}4^{1:}4^{2}$, which make n=4 in the general proportion $1:n:n^{2}$ where n is called is Bradford multiplier (Black 2004). Because 16 is far from the actual number 51, one can expect that the scattering of this data do not fit Bradford's-Zipf's law.

CONCLUSION

J.S. Yadav has published 722 papers during 1986 to May 2009. He published his first paper in 1986 when he was 36 years of age. The percentage of solo research papers (0.27) has been found to be very low. The percentage of collaborative work (99.7) was very high. He had of 408 scientist collaborators whom he guided as a mentor. His highest degree of collaboration 0.1925 was found during 2002-2003. His papers have been scattered in 56 high impact factor scientific journals. The h index of 41 after 24 years of scientific activity characterizes that he is an outstanding scientist in the field of chemical science. The awards he received during the last two decades have increased the visibility of his research worldwide and this visibility attracts more fellow scientists towards him as collaborators to raise the research productivity.

The quantitative data presented in this paper may give many interesting insights into J.S. Yadav's scientific career. Findings indicate his temporal publication productivity and the nature of the research activities were such that he is eminently qualified to be taken as a role model for the younger generation to emulate.

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