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## Research Article

### SIGNIFICANT CONTRIBUTION IN BIOTECHNOLOGY BY THE INDIAN SCIENTIST PROFESSOR ASHOK PANDEY-AN SCIENTOMETRIC ANALYSIS

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#### ABSTRACT

Indian scientists enhanced the science and technology landscape of the world. This present work aims to study about biographic study of Prof. Dr. Ashokpandey, Distinguished Scientist at Council of Scientific and Industrial Research - Indian Institute for Toxicology Research, Lucknow, India. A search was carried out in different databases like Google scholar, Scopus and Research Gate. He produced 713 research articles and reviews in the broad spectrum of Biotechnology between from 1976 to 2017 in which 506 of them were indexed by Scopus. He received totally 29607 citations for 713 publications with the average citations per items as 42 and H-index as 84. His 15 patents and 45 books could innovate and motivate the young talented researcher to create some significant contribution towards research.

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#### INTRODUCTION

India today has large number of well-equipped science institutions and organizations in every field equivalent to some of the most excellent internationally (Tandon2017). The Indian researcher's contribution to the global research activity has enlarged at an exponential scale in recent years. Prof. Dr. Ashok Pandey has been one of these renowned Indian researchers. This paper introduces the scientific biography of Prof. Dr. Ashok Pandey who has been one of the most important scientists of India in the area of Biotechnology.

Prof. Dr. Ashok Pandey was born in Kanpur, India in 1956. He studied together undergraduate and postgraduate in Kanpur University. He fruitfully completed his Ph.D. degree in Allahabad University, India, (1979) in the field of Microbiology as listed in the table 1 regarding his career development.

**Table 1** Prof. Dr. Ashok Pandey's Career development

Year	Qualification	Institution
1974	B.Sc	Kanpur University, Kanpur, India.
1976	M.Sc	Kanpur University, Kanpur, India.
1979	Ph.D	Allahabad University, Allahabad, India.
1979	Post-doctoral	Allahabad University, Allahabad, India.

1982	Fellow Scientist	National Sugar Institute, Kanpur, India.
1985	Scientist	Zentral Laboratorium, Sudzucker, Germany Council of Scientific and Industrial Research (CSIR)-National Institute for Interdisciplinary Science and Technology, Trivandrum, India
1987	Scientist	German Research Centre for Biotechnology, Germany
1992	Visiting Scientist	University of Louis Pasteur, France
1992	Visiting Scientist	University of Sunderland, United Kingdom.
1997	Professor	Titular, Federal University of Parana, Brazil
1998	Professor	UNESCO, Malaysia, Thailand
2000	Professor	Universite Blaise Pascal, France
2003	Visiting Professor	École polytechnique fédérale de Lausanne, Lausanne, Switzerland
2008	Visiting Professor	Centre for Innovative & Applied Bioprocessing, Mohali, India
2016	Eminent Scientist	Council of Scientific and Industrial Research (CSIR)-Indian Institute of Toxicology Research, Lucknow, India
2017	Distinguished Scientist	

He has started his career as Post-doctoral Fellow in Allahabad University, 1979. Followed with he has worked as Scientist in National Sugar Institute, Kanpur, India; Zentral Laboratorium, Sudzucker, Germany; CSIR-National Institute for

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Prof. Dr. Ashok Pandey is currently Distinguished Scientist at CSIR-Indian Institute for Toxicology Research, Lucknow, India and Honorary Executive Director at the Centre for Energy and Environmental Sustainability- India and former Eminent Scientist at the Centre of Innovative and Applied Bio processing, Mohali and Chief Scientist, Head of Biotechnology Division at CSIR's National Institute for Interdisciplinary Science and Technology at Trivandrum. He is adjunct Professor at VIT University, Vellore, Tamil Nadu; MACFAST, Thiruvalla, Kerala and Kalaslingam University, Krishnan Koil, Tamil Nadu, India.

He has served as a visiting Scientist to GBF, Germany (during Sept-Oct 1992); University of Louis Pasteur, France (during Dec 1992-Jan 1993 and during July-Dec 1995); University of Sunderland, UK (May 1997); and also as Visiting professor in Universite Blaise Pascal, France (June/July each year during 2003-2013); EPFL, Lausanne, Switzerland (December each year during 2008-2010); Professor in Titular, Federal University of Parana, Brazil (during April 1998-March 2000).

His major research interests are in the areas of Microbial Technology, Enzyme Technology and Food and Fermentation Technology, Energy and Environment, and Health & Nutrition which span over various programs, including Bioprocesses and products development, biopolymers, organic acids, amino acids, mushroom, biomass to fuels & chemicals, probiotics & nutraceuticals, industrial enzymes, solid-state fermentation, Biomass to fuels and chemicals (biorefinery); microbial biodiversity, Probiotics and nutraceuticals. He has supervised many research scholars and post graduate student from various Institutions across the world. He has conducted many Short-term training to various research scholars.

## MATERIALS AND METHODS

An analysis was executed in the databases including Scopus, Google Scholar, Research Gate and Science Direct in this germane study. Recently, most accurate authentication of authors' impact have been accomplished by the use of Scopus and Google Scholar (Mongeon and Hus2016). Elsevier, owning Scopus, recently added books to its database coverage. The list of journals published by the researcher from Google scholar and indexed in Scopus from the Elsevier website were downloaded. Science Citation index (SCI) has been exploited to utilize various research characteristics like impact factor and number of citations. And also a copy of the publication catalogue prepared by the Researcher was acquired. A number of preliminary explore approaches were executed to establish the papers written by the researcher.

## RESULTS AND DISCUSSION

### Research output

The research output of Prof. Dr. Ashok Pandey has been summarized in the table 2, which includes the records on the research papers published in the journals indexed by Scopus and also with papers published in the journals not indexed by Scopus. The researcher published 507 original and review papers which are indexed by the Scopus and published 206

which are not indexed by Scopus but indexed by Google scholar. Research Gate showed about 593 research items published by the researcher with RG score of 47.23. Totally 713 research papers were published by the researcher. The production rate was found to be 17.4 per year as on October 2017. During the period of 40 years the researcher published around 72% research articles in Scopus, which have been published in 102 scientific journals. Fig.1 represents that number of articles published by the researcher. There is gradual increase in number of papers published from 1976 to Oct 2017.

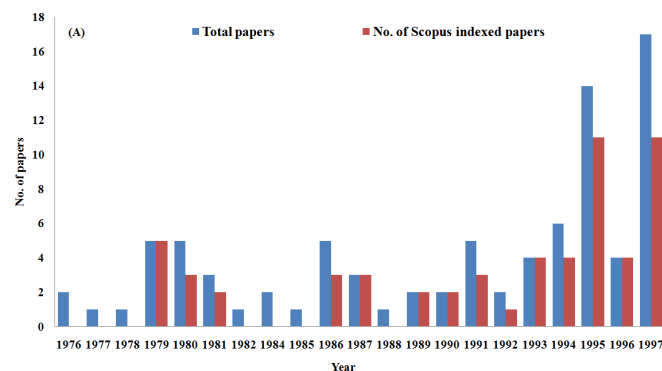


Fig 1 (A) No. of articles published by the researcher from 1976 to 1997

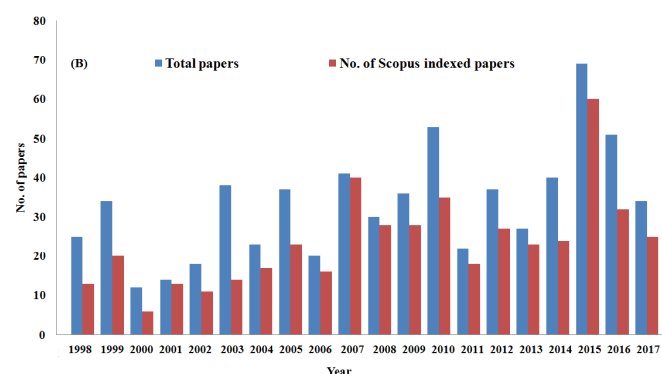


Fig 1 (B) No. of articles published by the researcher from 1998 to Oct 2017

Table 2 Research output by Prof. Dr. Ashok Pandey

Year	No. of Scopus indexed papers	No. of Scopus not indexed papers	Total papers	Total papers %
1976	0	2	2	0.2805
1977	0	1	1	0.1403
1978	0	1	1	0.1403
1979	5	0	5	0.7013
1980	3	2	5	0.7013
1981	2	1	3	0.4208
1982	0	1	1	0.1403
1984	0	2	2	0.2805
1986	0	1	1	0.1403
1987	3	2	5	0.7013
1988	3	0	3	0.4208
1989	0	1	1	0.1403
1990	2	0	2	0.2805
1991	2	0	2	0.2805
1992	3	2	5	0.7013
1993	1	1	2	0.2805
1994	4	0	4	0.5610
1995	4	2	6	0.8415
1996	11	3	14	1.9635
1997	4	0	4	0.5610
1998	11	6	17	2.3843
1999	13	12	25	3.5063
2000	20	14	34	4.7686

Year	No. of Scopus indexed papers	No. of Scopus not indexed papers	Total papers	Total papers %
2001	6	6	12	1.6830
2002	13	1	14	1.9635
2003	11	7	18	2.5245
2004	14	24	38	5.3296
2005	17	6	23	3.2258
2006	23	14	37	5.1893
2007	16	4	20	2.8050
2008	40	1	30	4.2076
2009	28	2	36	5.0491
2010	28	8	53	7.4334
2011	35	18	22	3.0856
2012	18	4	37	5.1893
2013	27	10	27	3.7868
2014	23	4	40	5.6101
2015	24	16	69	9.6774
2016	60	9	51	7.1529
2017	32	19	713	100
Total	506	207		

**Journals**

Impact factor of various journals have been obtained from SCI journal website and tabulated in Table 3. Since, the frequency of number of citation per year in a journal determines the impact factor (IF). And impact factor is used to assess the importance of a journal(Finardia2013).Out of all articles published by the researcher, 43 % of research papers were published in journals with impact factor higher than 1.0(305 papers).The maximum number of papers published around 68 papers in Bioresource technology with impact factor of 5.651.

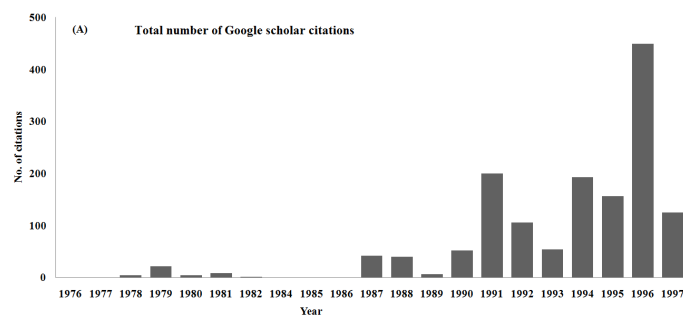
**Table 3** Journals with Impact factor

Journal name	Impact factor	Total no. of papers
Biotechnology Advances	10.597	3
Green chemistry	9.125	2
Journal of Hazardous Materials	6.065	1
Bioresource Technology	5.651	68
Fuel	4.601	1
Food chemistry	4.529	1
Renewable Energy	4.357	9
Journal of Molecular Catalysis A: Chemical	4.211	2
International Journal of Biological Macromolecules	3.671	2
Biotechnology	3.649	1
International Journal of Food Microbiology	3.339	2
Applied Microbiology and Biotechnology	3.337	2
Biomass and Bioenergy	3.219	2
Phytochemistry	3.205	1
Industrial Crops and Products	3.181	1
Journal of Chemical Technology and Biotechnology	3.135	2
Food Research International	3.086	8
Biochemical Engineering Journal	2.892	20
Journal of industrial microbiology and biotechnology	2.81	3
Catalysis Letters	2.799	2
Applied Soil Ecology	2.786	1
Plant Physiology and Biochemistry	2.724	1
Journal of Biotechnology	2.599	1
Enzyme and Microbial Technology	2.502	6
Process Biochemistry	2.497	28
LWT - Food Science and Technology	2.329	31
Journal of Bioscience and Bioengineering	2.24	2
ActaTropica	2.218	1
International Journal of Systematic and Evolutionary Microbiology	2.134	3
biotechnology progress	1.986	3
Biocatalysis and Agricultural Biotechnology	1.87	1
Journal of Food Science	1.815	1
Journal of Microbiology and Biotechnology	1.75	1

Journal name	Impact factor	Total no. of papers
Biotechnology Letters	1.73	6
Engineering in Life Sciences	1.698	2
ActaBiotechnologica	1.698	3
Letters in Applied Microbiology	1.575	5
Folia Microbiologica	1.521	2
Journal of Basic Microbiology	1.438	10
Applied Biochemistry and Biotechnology	1.429	32
Biotechnology and Applied Biochemistry	1.429	3
Preparative Biochemistry and Biotechnology	1.361	1
Current Microbiology	1.322	2
Indian Journal of Microbiology	1.29	7
Annals of Tropical Medicine and Parasitology	1.288	1
Bioprocess Engineering	1.211	1
Indian Journal of Experimental Biology	1.165	13
Biofuels	1.16	1
Annals of Microbiology	1.122	1
Bioremediation Journal	1.098	1
Brazilian Journal of Microbiology	1.091	1

**Citation analysis**

Current scientific development depends on appearance of citations through a network made between authors and readers. Google Scholar is recommended for retrieval of information and also provides free access for all fields in all languages (Mingers *et al.* 2017; Harzing and Alakangas2016). Research activities of all researchers can be observed with RG Score through Research Gate. (Thelwall and Kousha 2017).Citation studies result in Theoretical comprehensibility about what is to be described on scientific research by providing valuable information through the authors to the readers (Leydesdorff 1998). Fig 2. summarizes the citations analysis obtained from the use of “Google scholar” database. Bertoli-Barsotti and Lando (2017) proposed the importance of H- index from citation pattern. The researcher received a total of 29607 citations for 714 publications with the average citations per items as 41.46 and H-index as 84. Research Gate showed 22,694 citations with 75 H-index for the researcher. Whereas citation analysis made from Scopus showed totally 18123 citations for 506 publications and the average citations per items as 35.81as shown in Fig 3.



**Fig 2 (A)** Citational analysis by using Google scholar for the researcher from 1976 to 1997

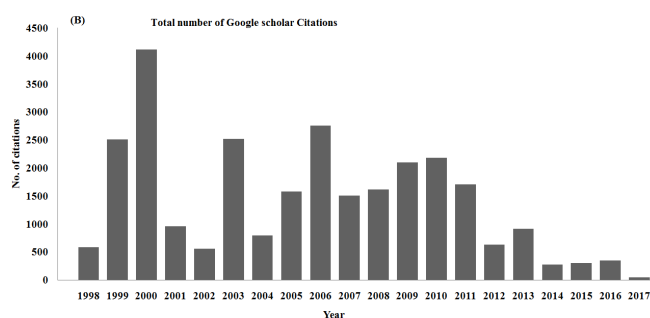


Fig 2 (B) Citational analysis by using Google scholar for the researcher from 1998 to 2017

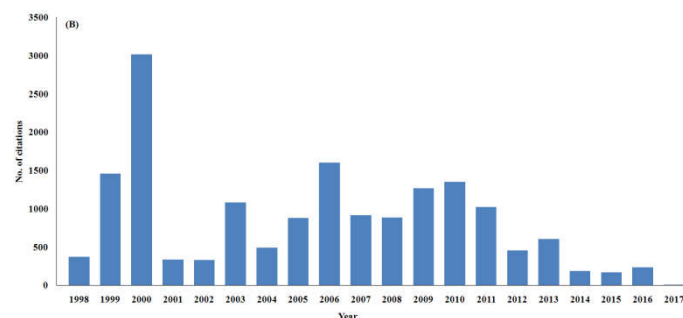


Fig 3(B) Citational analysis by using Scopus for the researcher from 1998 to 2017

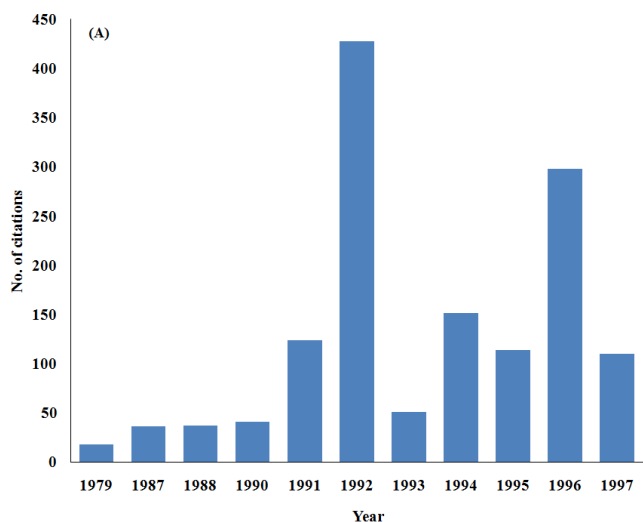


Fig 3(A) Citational analysis by using Scopus for the researcher from 1979 to 1997

The papers with highest impact on the relevant research through the citation analysis for both Scopus indexed and non-indexed papers results are represented with citations over 300 in Table 4. Nineteen papers and one booked had received citations over 300 are identified from Google scholar database till August 2017. A review paper entitled, “Solid-state fermentation” published in a journal with 2.892 Impact factor had received 1541 citations over 14 years since 2003. Another review paper on the same topic had received citations more than 1000, published in Process biochemistry journal with in the 2000 edition with 2.497 Impact factor.

Out of all papers published by Dr. Ashok Pandey, 59 papers had received citations over 100 with 8.48% and 79 papers had received citations between 50 and 100 with 11.35% (data not shown).

Table 4 Exclusive Citations

Title	Journal	Year of publication	Citation no.	Reference
Solid-state fermentation	Biochemical Engineering Journal	2003	1584	(Pandey 2003)
New developments in solid state fermentation: I-bioprocesses and products	Process biochemistry	2000	1048	(Pandey et al. 2000a)
Biotechnological potential of agro-industrial residues. I: sugarcane bagasse	Bioresource technology	2000	972	(Pandey et al. 2000b)
Solid state fermentation for the production of industrial enzymes	Current science	1999	892	(Pandey et al. 1999a)
The realm of microbial lipases in biotechnology	Biotechnology and applied biochemistry	1999	757	(Pandey et al. 1999b)
Micro and macroalgal biomass: a renewable source for bioethanol	Bioresource technology	2011	635	(John et al. 2011)
Bioethanol production from rice straw: an overview	Bioresource technology	2010	519	(Binod et al., 2010)
Recent advances in solid-state fermentation	Biochemical Engineering Journal	2009	515	(Singhania et al., 2009)
Fermentative production of lactic acid from biomass: an overview on process developments and future perspectives	Applied microbiology and biotechnology	2007	459	(John et al., 2007)
a-Amylases from microbial sources—an overview on recent developments	Food Technology and Biotechnology	2006	453	(Sivaramakrishnan et al. 2006)
Use of response surface methodology for optimizing process parameters for the production of α-amylase by Aspergillusoryzae	Biochemical Engineering Journal	2003	395	(Francis et al. 2003)
Biotechnological potential of agro-industrial residues. II: cassava bagasse	Bioresource technology	2000	399	(Pandey et al. 2000c)
Solid-state fermentation in biotechnology: fundamentals and applications	Asiatech Publishers (Book)	2001	384	(Pandey et al. 2001)
Cellulase production using biomass feed stock and its application in lignocellulose saccharification for bio-ethanol production	Renewable energy	2009	367	(Sukumaran et al. 2009)
Microbial cellulases-production, applications and challenges	Journal of scientific and Industrial research	2005	353	(Sukumaran et al. 2005)
Biotechnological potential of coffee pulp and coffee husk for bioprocesses	Biochemical Engineering Journal	2000	340	(Pandey et al. 2000d)
Advancement and comparative profiles in the production technologies using solid-state and submerged fermentation for microbial cellulases	Enzyme and Microbial Technology	2010	317	(Singhania et al. 2010)
Comparative evaluation of neutral protease production by Aspergillusoryzaein submerged and solid-state fermentation	Process biochemistry	2005	311	(Sandhya et al. 2005)
Gluconic acid: properties, applications and microbial production	Food Technology and Biotechnology	2006	310	(Ramachandran et al. 2006)
Production, purification and properties of microbial phytases	Bioresource technology	2001	310	(Pandey et al. 2001)

## Patents and Books

Beside patents, he is the inventor of nearly 15 no. of patents and has one copy right for “Engineering design for Centre for Biofuels” and edited the science books, “The Realm of Industrial Biotechnology” (Pandey2000f) and Threads of Life (Pandey1998). Table 5 represents the topics related to patents approved by US patent and Indian patent belongs to Prof.Dr. Ashok Pandey.

**Table 5 Patents**

Topic	Year	Reference
Solid state fermentation	2013	(Saudagar <i>et al.</i> 2013)
Clavulanic acid production	2012	(Banerjee <i>et al.</i> 2012)
Lactic acid production	2000-2011	(Pandey 2010f) (Nampoothiri <i>et al.</i> 2011) (Pandey <i>et al.</i> 2000e)
Arginine production	2010	(Nampoothiri <i>et al.</i> 2010)
L-Methionine amino peptidase production	2008	(Ahmed <i>et al.</i> 2008)
Linolenic acid production	2006	(Saudagar <i>et al.</i> 2006)
Preparation of clavulanic acid	2004	(Babitha and Pandey 2004)
Production of food grade red pigments	2004-2011	(Nampoothiri and Pandey 2011)(Pandey <i>et al.</i> 2004)
Production of phytase	2000	(Soccol <i>et al.</i> 2000)
Production of xanthan gum	1995	(Pandey and Balakrishnan1995)
Cyclosporin A production	1996	(Pandey <i>et al.</i> 1996)
Production of fungal spores	1991	(Pandey 1991)
Preparation of glucoamylase enzyme		

Some of the research work done by the researcher has received a great attention towards industry point of view. Solid-state fermentations for the production of various valuable products like cellulose, phytase, food grade alpha amylase, and xylanase from different substrates have been commercialized from lab scale to industrial scale. He is the author for an Encyclopaedia named ‘Concise Encyclopaedia of Bioresource Technology’ since 2004 and also 48 numbers of books have been published by foremost publishers.

## Awards and achievements

Prof. Dr. Ashok Pandey is the recipient of many national and international awards and fellowships, which include Life-Time Achievement Award from the International Society for Energy, Environment and Sustainability (2017); Fellow of Royal Society of Biology, UK (2016), Academician of European Academy of Sciences and Arts, Germany (2016); Fellow of International Society for Energy, Environment and Sustainability (2014); Fellow of National Academy of Science, India (2012); Fellow of Association of Microbiologists of India (2010); Fellow of International Organization of Biotechnology and Bioengineering (2008); Fellow of the Biotech Research Society, India (2005); Honorary Doctorate degree from Univesite Blaise Pascal, France (2007); Thomson Scientific India Citation Laureate Award, USA (2008); Lupin Visiting Fellowship, Visiting Professor in the University Blaise Pascal, France; Federal University of Parana, Brazil and EPFL, Switzerland, Best Scientific Work Achievement award, Govt of Cuba; UNESCO Professor; Raman Research Fellowship Award, CSIR; GBF, Germany and CNRS, France Fellowship; Young Scientist Award, etc. He was Chairman of the International Society of Food, Agriculture and Environment, Finland (Food & Health) during 2003-2004. He is the Founder and President of the Biotech Research Society, India (www.brsi.in); International Coordinator of International

Forum on Industrial Bioprocesses, France (www.ifibiop.org), Chairman of the International Society for Energy, Environment & Sustainability (www.isees.in) and Vice-President of All India Biotech Association (www.aibaonline.com).

Prof. Dr. Ashok Pandey is currently Editor-in-chief of Bioresource Technology, Honorary Executive Advisors of Journal of Water Sustainability and Journal of Energy and Environmental Sustainability, Subject editor of Proceedings of National Academy of Sciences (India) and editorial board member of several international and Indian journals. He is editor-in-chief of two book series, one on Current Developments in Biotechnology and Bioengineering, comprising ten books published by Elsevier, and another on Biomass, Biofuels and Biochemical being published by Elsevier.

## CONCLUSIONS

In this present study, biography of Prof.Dr. Ashok Pandey is presented. He contributed his life towards research activities for past four decades. The results obtained from this study showed that the researcher had developed gradually in terms of review papers, original articles and books from 1976 to 2017. The results also delivered valuable information about Prof. Dr. Ashok Pandey like total number of citations, Average Citations per Item, and H-index. There were 29607 citations to 713 papers with 84 H-index as of October 2017.

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