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Mapping the Indian research productivity of food science and technology: A scientometric analysis

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Abstract

An analysis of 1060 publications published by Indian scientists during 1998 to 2010 and indexed by Web of Science online Database indicates that the publication output in the Indian Research Publication. Centre Food Technology Research Institute, BARC, Indian Institute of Technology, Defense Food Research Lab and institutes are the major producers of research output. Most of the prolific authors are from the highly productive institutions. This work is to provide a profile of research in Indian Research Publication in India. This includes tracking the number of papers, scatter of papers over journals, and its effect on publication output, authors' institutional affiliations and authorship patterns.

Keywords: Scientometrics, Food Science and Technology, Science Citation Index

INTRODUCTION

India is the world's largest producer of food, next to China, and has the potential of being the largest with the potential of being the largest with the food and agricultural sector. There is an opportunity for large investments in food and food processing technologies, skills and infrastructure, especially in areas of canning, dairy packaging, frozen food / refrigeration and thermo processing. Fruits and vegetables, milk and milk products, meat and poultry, packaged / convenience foods are important sub-sectors of the food processing industry. It requires increase India's contribution to research in food science and technology is assessed from an analysis of publications indexed in ISI. Food scientists develop and improve ways to process raw ingredients, such as grains, meats, milk, fruit and vegetables to safe, tasty and nutritious foods. Scientometrics is concerned with the quantitative features and characteristics of science and scientific research. Emphasis is placed on investigations in which the development and mechanism of science are studied by statistical mathematical methods.

OBJECTIVES

The main objective of this study was to use Scientometric mapping and analyze the key features of Food Science and Technology research activities at India level:

- To identify and analyse the rate of growth of research productivity on Food Science and Technology;
- To note the document wise distribution of publications;
- To analyse the authorship pattern and examine the extent of research collaboration;
- To identify the ranking of authors based on publications;
- To identify journal wise distribution of publications;
- To assess the Institution wise research concentration
- To identify country wise Collaborative Distribution of Publications;
- To test the Bradford's law of scattering in Food Science and Technology research output;

METHODOLOGY

This analytical study encompassing records output on Science from Science Citation Index (SCI) available on online (Web of Science). The present study aims at analyzing the research output of Researchers in the field of food science and technology. The growth rate of output in terms of research productivity is analyzed from 1998 to 2010. The authorship pattern and author productivity are examined to identify the pattern of research contribution in the field of food science and technology. The area-wise research performance is analyzed to identify hot area of research. Further, an attempt is made to measure the performance of researchers and their research concentration in the field of food science and technology and it is also analytical in nature in strengthening the empirical validity due to application of suitable statistical tools.

ANALYSIS AND INTERPRETATION

Relative Growth Rate of Publications

To analyze the year wise publication of research on food science and technology, the data has been presented in Table 1. The research output on Science and Technology publication is taken as a tool to evaluate the performance at various levels. It also shows that chronological histogram of citations, demonstrating that citation frequency grew steadily from 1998; it reached a maximum GCS of 1199 in 2007 and LCS of 53 in 2007.

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Table 1 could clearly see that during the period 1998 to 2010 a total of 1060 publications were published at India level. The highest publication is 146 in 2008 with 635 TGCS followed by 143 papers in 2007 with 1199 TGCS and 88 papers in 2006 with 713 TGCS. The lowest publication is 4 in 2011 with 1 TGCS. It shows that even minimum numbers of records were scored higher global citations. The study also reveals all these 1060 publications have 42626 cited references it shows that there is a healthy trend in citing reference is found in food science and technology.

Table 1: Shows relative growth rate of Food Science and Technology Publications

S.No	Year	Pub. output	W_1	W_2	R (a) (W_2- W_1	D_t	TLCS	TGCS	% of Papers
1	1998	11	-	2.39	-	-	4	54	1.0
2	1999	43	2.39	3.76	1.36	0.51	36	400	4.1
3	2000	42	3.76	3.74	0.02	28.88	21	275	4.0
4	2001	46	3.74	3.83	0.09	7.62	41	645	4.3
5	2002	46	3.83	3.83	0	0	36	661	4.3
6	2003	64	3.83	4.16	0.33	2.1	47	688	6.0
7	2004	69	4.16	4.23	0.08	9.12	46	841	6.5
8	2005	77	4.23	4.34	0.11	6.36	45	898	7.3
9	2006	88	4.34	4.48	0.13	5.17	20	713	8.3
10	2007	143	4.48	4.96	0.48	1.43	53	1199	13.5
11	2008	146	4.96	4.98	0.02	33	26	635	13.8
12	2009	140	4.98	4.94	0.04	16.5	15	386	13.2
13	2010	145	4.94	4.98	0.04	19.8	4	138	13.6
					2.7 (0.20)	130.5(10.03)			100

It is observed that its relative growth rates have decreased gradually from 1.36 in 1998 to 0.04 in 2010. The whole study period records the mean relative growth rate of 0.20. Contrarily, the doubling time for publication of all sources of output has increased from 0.51 in 1998 to 19.8 in 2010. The doubling time for publications at the aggregate level has been computed as 10.03 years.

Document wise Distribution of Publications

The study reveals that the major source of publications covered by web of science on food science and technology research in journal articles (88%), while review comprises (9.3%) and conference proceedings with (2.2%) of the remaining literature.

Table 2 shows document wise distribution of Publications

S.No	Document Type	Publications	%	Cum. %	TLCS	TGCS
1	Article	932	88.0	88.0	352	5833
2	Review	99	9.3	97.3	39	1591
3	Proceedings Paper	23	2.2	99.5	1	106
4	Correction	3	0.3	99.8	1	2
5	Editorial Material	1	0.1	99.9	0	0
6	Reprint	1	0.1	100	1	2
	Total	1060	100			

Single Vs. Multiple Authors

It is found from the study that multiple authors' research is ensured between the authors in Food Science and Technology research as 95.94% of publications made by multiple authors.

Table 3: Authorship Pattern

Authorship Patterns	Publications	Cum. output	%	Cum %
Single Author	43	43	4.06	4.06
Double Authors	282	325	26.60	30.66
Three Authors	325	650	30.66	61.32
Four Authors	210	860	19.81	81.13
Five Authors	118	978	11.13	92.26
Six Authors	44	1022	4.15	96.41
Seven Authors	19	1041	1.79	98.2
Eight Authors	5	1046	0.47	98.67
Nine Authors	4	1050	0.38	99.05
Ten & above	10	1060	0.95	100
Total	1060		100	

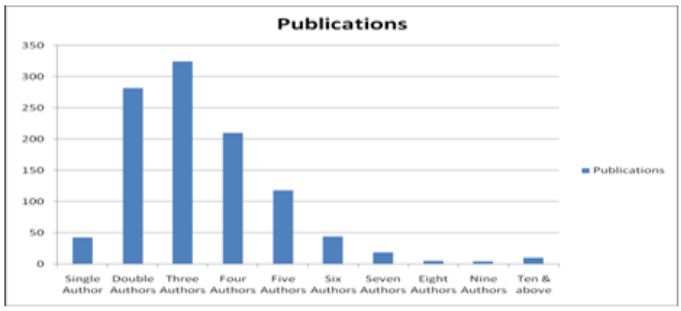


Figure 1: Showing collaboration pattern of authors

It is found from the study that collaborative research is ensured between the authors in Food Science and Technology research as 30.66% of publications made by three authors. More than 60% of the research papers are published by 3 to 4 authors. It is also found that the papers published by more than 10 authors.

Ranking of Authors based on Publications

Table 4 indicates ranking of authors by number of publications. Authors "Sharma .A" published highest number of articles for the study period with 28 records, next two consecutive authors Bawa .A.S. and Singhal R.S. are published next highest number of articles for the study period with 22 records each. Thus the most-cited authors are distinguished from the most-published ones. It is found from the analysis that Lotka's law may not be applicable with regard to author productivity in proliferation of research in food science and technology as the research papers equally distributed by a large number of authors.

Table 4: Shows Ranking of Authors (Top 10)

#	Author	Records	%	TLCS	TGCS	TLCR
1	Sharma A	28	2.6	13	242	23
2	Bawa AS	22	2.1	3	63	9
3	Singhal RS	22	2.1	6	139	5
4	Singh G	20	1.9	19	221	17
5	Singh P	19	1.8	10	106	28
6	Dubey NK	16	1.5	30	135	32
7	Kumar A	16	1.5	12	113	25
8	Srinivasan K	15	1.4	19	187	18
9	Das M	14	1.3	6	65	9
10	Kumar R	13	1.2	19	92	10

Journal wise Distribution of Publications

The study found that the total research output of the Food Science and Technology for the study period (1998 – 2010) published in 86 journals. As the major portion of the research productivity (76.2%) covered by 25 journals that is coincide with the theory of Bradford's Law of scattering of journals in research productivity. Top ten produced mostly 55% of the research output. The journal "Food Science and Technology" topped with 179 publications with the Global Citation Score of 329, next "Food Chemistry" 96 publications with the Global Citation Score of 1233 and "LWT-Food Science and Technology" with 60 publications with the Global Citation Score of 397 respectively. "Food Chemistry" has scored the highest Global Citation Score of 1233 with 96 publications while "Biotechnology Progress" has scored Global Citation Score of 73 with just 4 records.

Table 5: Distribution of Food Science and Technology in Journal Publications

S.No	Journal	Records	%	TLCS	TGCS	TLCR
1	JOURNAL OF FOOD SCIENCE AND TECHNOLOGY-MYSORE	179	16.9	29	329	32
2	FOOD CHEMISTRY	96	9.1	58	1233	40
3	LWT-FOOD SCIENCE AND TECHNOLOGY	60	5.7	7	397	26
4	JOURNAL OF AGRICULTURAL AND FOOD CHEMISTRY	54	5.1	43	822	25
5	FOOD AND CHEMICAL TOXICOLOGY	41	3.9	6	242	20
6	JOURNAL OF FOOD ENGINEERING	40	3.8	16	303	7
7	INTERNATIONAL JOURNAL OF FOOD SCIENCE AND TECHNOLOGY	30	2.8	16	83	17
8	FOOD RESEARCH INTERNATIONAL	29	2.7	11	235	13
9	INTERNATIONAL JOURNAL OF FOOD SCIENCES AND NUTRITION	25	2.4	19	212	10
10	JOURNAL OF THE SCIENCE OF FOOD AND AGRICULTURE	25	2.4	12	108	19

Bradfor's Law

Table 6: Shows Scattering of Bradford's law

No of Journals	No of Contribution	Total No of Contribution	Cumulative Total
1	129	129	129
1	85	85	214
1	58	58	272
1	54	54	326 (326)
1	41	41	367
1	40	40	407
1	35	35	442
1	26	26	468
2	21	42	510
1	20	20	530
1	18	18	548
1	15	15	563
2	14	28	591
3 (14)	11	33	624 (298)
5	10	50	674
6	9	54	728
5	8	40	768
3	7	21	789
5	6	30	819
5	5	25	844
8	4	32	876
8	3	24	900
9	2	18	918
14 (68)	1	14	932 (308)
86		932	

Table 7: Shows Bradford's Law

Zone	No. of Journals	No. of Records	Multiplier Factor
1	4(4.65)	326(30.75)	-
2	14(16.27)	298(28.11)	3.5
3	68(79.06)	308(29.05)	4.85
	86	1060	4.18

Table 6 & 7 reveals that the observation of that the small groups of four journals are identified in the nuclear or core zone representing 4.65 percent of total journals cover maximum segment of information with (326)30.75 percent of articles. While the second larger group of 14(16.27%) journals provides 298(28.11%) articles, and the third largest of 68(79.06%) of periodicals yield the next 308(29.05%) article publication. The Bradford multiplier between the number of references in zone 1 and zone 2 is 3.5 while it is 4.85 between zone 2 and zone 3.

The average multiplier is 4.18 According to Bradford, 4:14:68

Institution wise Distribution of Publications

The below table analysis indicates Institution-wise research productivity. It is noted that 58 institutions were contributed of the total research productivity in the subject of food science. It is noted that Cent Food Technol Res Inst contributed the highest number of research publications (164) at the same time it ranks first in terms of Global Citation Score 2796.

Table 8: Institution wise Distribution of Publications (Top 10)

#	Institution	Records	%	TLCS	TGCS
1	Cent Food Technology Research Institute	164	15.5	120	2796
2	Bhabha Atom Res Centre	41	3.9	42	425
3	Indian Institute Technology	34	3.2	21	206
4	Def Food Res Lab	25	2.4	13	129
5	Indian Vet Research Institute	21	2.0	1	76
6	University Mysore	18	1.7	10	118
7	Govind Ballabh Pant Univ Agr & Technol	17	1.6	2	31
8	Natl Dairy Res Institute	14	1.3	6	144
9	University Bombay	14	1.3	9	125
10	CSIR	13	1.2	2	201

Funding Agency

various funding agencies are supported for this kind of research. Particularly in this food science filed, below mentioned agencies are supported. "CSIR, New Delhi" has supported eight and seven more articles. UGC sponsered by seven articles. Rremaining funding agencies are supported by each two articles.

Table 10: Shows Funding Agency support for the researchers

Funding Agency	Record Count	% of 1060
COUNCIL OF SCIENTIFIC AND INDUSTRIAL RESEARCH CSIR NEW DELHI INDIA	8	0.75
CSIR	7	0.66
UNIVERSITY GRANTS COMMISSION NEW DELHI	7	0.66
COUNCIL OF SCIENTIFIC AND INDUSTRIAL RESEARCH NEW DELHI INDIA	6	0.57
CSIR NEW DELHI	6	0.57
UNIVERSITY GRANTS COMMISSION NEW DELHI INDIA	5	0.47
COUNCIL OF SCIENTIFIC AND INDUSTRIAL RESEARCH NEW DELHI	4	0.38
COUNCIL OF SCIENTIFIC AND INDUSTRIAL RESEARCH CSIR INDIA	3	0.28
DEPARTMENT OF BIOTECHNOLOGY NEW DELHI INDIA	3	0.28
INDIAN COUNCIL OF MEDICAL RESEARCH NEW DELHI	3	0.28
CENTRAL FOOD TECHNOLOGICAL RESEARCH INSTITUTE CFTRI MYSORE INDIA	2	0.19
CFTRI	2	0.19
COUNCIL OF SCIENTIFIC AND INDUSTRIAL RESEARCH CSIR	2	0.19
COUNCIL OF SCIENTIFIC AND INDUSTRIAL RESEARCH CSIR GOVT OF INDIA	2	0.19
COUNCIL OF SCIENTIFIC AND INDUSTRIAL RESEARCH CSIR NEW DELHI	2	0.19
COUNCIL OF SCIENTIFIC INDUSTRIAL RESEARCH CSIR GOVERNMENT OF INDIA NEW DELHI	2	0.19
COUNCIL OF SCIENTIFIC INDUSTRIAL RESEARCH NEW DELHI INDIA	2	0.19
CST U P	2	0.19
DEPARTMENT OF SCIENCE AND TECHNOLOGY DST NEW DELHI	2	0.19
DEPARTMENT OF SCIENCE AND TECHNOLOGY GOVERNMENT OF INDIA	2	0.19
EUROPEAN UNION	2	0.19
INDIAN VETERINARY RESEARCH INSTITUTE	2	0.19
UNIVERSITY GRANTS COMMISSION	2	0.19
(919 records (86.6981%) do not contain data in the field being analyzed.		

Global Citation Scores - interlinks

The top 10 Global Citation Scores papers the most cited research papers span the period from 1998 to 2010 with one major network. There are only 27 links with GCS ranging between maximum 222 and minimum 17.

Table 12: Global Citation Scores of Top 10

S.No	Node	Author / Year / Journal	LCS	GCS
1	3	Subramanian R, 1998, FOOD RES INT, V31, P587	0	17
2	12	Venugopal V, 1999, CRIT REV FOOD SCI NUTR, V39, P391	4	43
3	17	Gujral HS, 1999, FOOD RES INT, V32, P691	0	17
4	35	Buldini PL, 1999, J AGR FOOD CHEM, V47, P1993	0	19
5	37	Ramesh MN, 1999, J FOOD ENG, V40, P199	0	17
6	38	Jayaprakasha HM, 1999, J FOOD SCI TECHNOL-MYSORE, V36, P189	3	27
7	49	Rastogi NK, 1999, J FOOD SCI, V64, P1020	5	92
8	60	Madhusudhan B, 2000, Lebensm-Wiss Technol-Food Sci, V33, P268	0	23
9	61	Thakur S, 2000, LEBENSM-WISS TECHNOL-FOOD SCI, V33, P354	2	28
10	71	Warke R, 2000, FOOD CONTROL, V11, P77	1	22

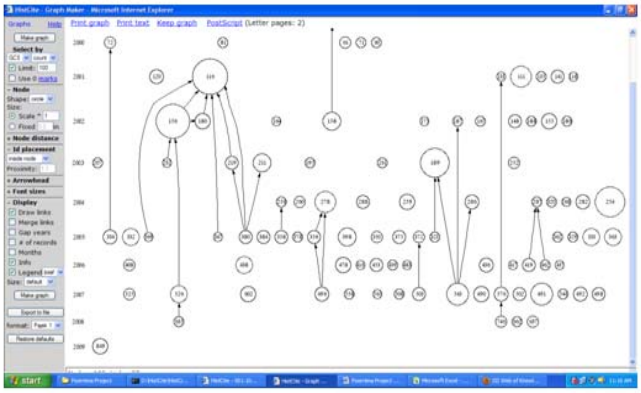
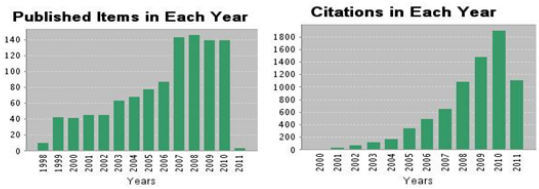


Fig. 2: Shows Food Science and Technology - Historiograph by top 100 GCS
Nodes: 100, Links: 27, GCS, top 100; Min: 17, Max: 222 (GCS scaled)

Citation Scores and H-Index

The table 12 shows the papers sorted by Global Cited Reference frequency that is cited. In this way, one sees that the group of citing papers includes a large number of highly cited papers we would describe as Citation Classics. The sum of the current times cited is 7541, Average Citations per time is 7.11 and h-index is 35.



The h-index is based on a list of publications ranked in descending order by the Times Cited. The value of h is equal to the number of papers (N) in the list that have N or more citations. This metric is useful because it discounts the disproportionate weight of highly cited papers or papers that have not yet been cited. In the h-index example below, the h-index is 3 because there are 3 articles with 3 or more citations that appear above the green line.

Results found : 1,060 Sum of the Times Cited : 7,541
Average Citations per Item : 7.11
h-index : 35

CONCLUSION

A major work of the Scientometrician is to continue to develop the techniques which will be more reliable and useful for evaluation and prediction, because Scientometric data mirror the actual published results of the work of researchers. Based on the analysis undertaken the present study, the following findings are drawn.

- ✓ The findings of Indian research productivity in food science and technology is the highest publication is 146 in 2008 with 635 Global Citation Scores followed by 143 papers in 2007 with 1199 Global Citation Score and 88 papers in 2006 with 713 Global Citation Scores. The lowest publication is 4 in 2011 with 1 Global Citation Scores.
- ✓ The authorship pattern of Indian research productivity of food science and technology identified that majority of papers are multi-authored.
- ✓ The study found that the total research output of the Food Science and Technology for the study period (1998 - 2010) published in 86 journals. As the major portion of the research productivity (76.2%) covered by 25 journals that is coincide with the theory of Bradford's Law of scattering of journals in research productivity.
- ✓ Top 58 institutions were contributed 577(54.43%) articles of the total research productivity.
- ✓ The trend towards collaborative research is gaining day-by-day.

This study has highlighted quantitatively the contributions made by the Indian researchers during 1998-2010 as reflected in Web of Science database. During 13 years period (1998 - 2010) Indian contributions in terms of number of publications is significant. A comparison of Indian output in relation to the world output may help in understanding the contribution in a better angle. Though the records available in the Web of Science database reveal a small number, it is important that the Web of Science covers only the peer-reviewed journals. If a broader coverage database is available, it may provide a reasonable number of papers. Researcher suggest for tracking citation record of papers so that the impact of publications in Food Science and Technology may be visible.

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