SCIENTOMETRIC ANALYSIS OF NANOTECHNOLOGY LITERATURE FROM 2000-2016 AS REFLECTED IN WEB OF SCIENCE DATABASE

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Abstract: The present study elaborates that Nanotechnology is most emerging subject day by day most of the research taken place in this subject from the year 2000- 2016 the highest number of articles were contributed in the field of nanotechnology was featured in the year 2016, while lowest number of articles were found in the year 2000 i.e. 30 articles (0.38 percent). 5871 publications were in the form of journal articles dominated the highest contribution where the total number of publications were 8000. Among top 50 authors based on publishing maximum no. of publications. The highest number of articles contributed by Wang J. i.e. 51 (4.78%) publications out of 1060 articles. The total research publications (8000) on nanotechnology were published in the seventeen different languages. Among them English language publications were the maximum literature output with a record count of 7655 with citation count of 147859 as global citation score and 2488 local citation score, where Chinese is second highest . The most productive journals in the field of nanotechnology are three (Namely Microelectronic Engineering, Advanced Powder Technology and Journal of Nanoscience and Nanotechnology). 17.04 % of world's share was published in these journals.

Keywords: nanotechnology, Zipf's law

Introduction:

Nanotechnology is quite a new branch of science and engineering and there has been criticism from some groups who fear there may be risks to humans and the environment that we don't know about yet, for example tiny nano particles may be toxic under certain circumstances. Nanotechnology is field of science deals with the extremely small elements/ particles in range i.e. from 1 to 100mm and can be used across all other science fields, such as chemistry, biology, physics, materials science, and engineering. The growing demands of information technology for more powerful microelectronic circuits force the transaction of nanotechnology.

Nanotechnology is wide-ranging and also it could include medicine, military applications, computing and astronomy. Nanotechnology is being used already in certain materials like self-cleaning glass, sunscreens, lipsticks and even antibacterial socks, there are even scientists thinking that nano foods could be used to trick the body into feeling fuller for longer, stopping us from overeating.

Review of literature:

1.   Shridevi Prakash Sindagi and Gavisiddappa Bhalappa Anandhalli (2018) have relieved that authorship trend and collaborative research in the area of lung cancer literature based on 93512 scholarly communications appeared in the lung cancer literature during 1997 to 2016.The study elaborates on various bibliometric components such as year wise distribution of articles, relative growth rate, doubling time, authorship pattern and collaborative coefficients. High degree of collaborative research (0.92) was found in the field of lung cancer which shows there is trend towards collaborative research. The Lotka's distribution is well fitted and followed in the area of Lung cancer which is confirmed with K-S test. The highest number of publication has been contributed by two authors (13301-14.2%) followed by three authors (11869- 12.69%).To examine the trend of research in the area of lung cancer with respect to authorship pattern. There is a high percentage of growth of publication was observed in case of single author (11.61%) for ten years (2021). The considerable percent of growth was observed (32%) for the period twenty years (2031) in the field of lung cancer. Finally, it can be concluded that, the major research activity is taking place in the area of Lung Cancer.

2.   Hadagali and Anandhalli (2015) have revealed that the growth of neurology literature for the period 1961-2010. A total of 291702 records were collected from the Science Direct Database for fifty years. The Relative Growth Rate (RGR) and Doubling Time (Dt) of neurology literature have been calculated, supplementing with different growth patterns to check whether neurology literature fits exponential, linear and logistic model. The result of the study indicates that the growth of literature in neurology does not follow the linear or logistic model. However, it follows closely the exponential growth model. The study concludes that there has been a consistent trend towards increased growth of literature in the field of neurology.

3.   Neelamma and Gavisiddappa Anandhalli(2016) have highlighted the research collaboration and authorship pattern in the area of Biology based on 1183 scholarly communication appeared in the Botany during 2005- 2014. Study elaborates various significant aspects like trends of authorship, author productivity, collaborative index, degree of collaboration, Relative growth rate (RGT) and Doubling Time (Dt), geographical wise distribution. USA contributed high numbers of article in the field of Botany literature, collaborative research is more popular among botany literature, lastly verified through Kolmogorov Simonov test. It can be concluded that botany literature does not follow the Lotka's law of author productivity and found that there is a negative Co-relation in botany literature.

4.   Chandran Velmurugan and Natarajan Radhakrishnan(2016)have observed that literature growth in Nanotechnology in Canada retrieved from Web of Science database. in this article tried to find out the highly cited articles, authors and other parameters with 576 scientific research papers during the period between 1994 and 2014. The average number of literature output year was 33.88 and the highest number of publications was published during 2013-2014. A total number of authors was 2213 and the maximum number of authors was 364 with the mean value of 4.77(2014). Out of 15804 citations, the large number of (2791) citations was in 2008 (52 papers, 23 h-index) and highest average citation per paper was 60.74 in 2007.

5.   Neelamma and Anandhalli (2016) have observed that research output performance of Botany Literature. Citation analysis of all the journal articles published in the Botany literature, which covered in Web of Science (on-line version database) for the period of 2005-2014. A total of 12051 references cited in 1183 articles in 572 journals. The study elaborates on various bibliometric components such as distribution of citations for Document type, Language wise distribution of citations, and Country wise publication of citations. Further the study also lists out the most productivity journals in the field of Botany Literature. The analysis of the results shows that out of 12051 citations, 61.96% Research articles contribute the highest number of citations and it is the most preferred sources of information used by researchers in the field of Botany. The USA is the most cited country in the world and the English language is the most preferred language in the world. Bradford's law well fitted into the given data set for the present study. Finally it can be concluded that, The Significant research activity is being taking place in the area of Botany and it is one of the emerging research field in the Biological Sciences.

6.   Neelamma and Gavisiddappa (2016).The purpose of this paper is to determine the materials cited in zoology literature during the year 2005–2014. The data were extracted from Web of Science citation index database. The study reveals that distribution of citations for document type, language wise distribution of citations and country wise distribution of citations. Further the study also lists out the most productivity journals in the area of zoology literature. The analysis of the results shows that out of 5332 citations, 74.81% research articles contribute the highest number of citations and it is the most preferred sources of information used by researchers in the area of zoology. The USA (33.75%) is the most cited country in the world and the English language (98.59%) is the most preferred language in the world. Bradford's law well fitted into the given data set for the present study. Finally it can be concluded that, The significant research activity is being taking place in the field of zoology and it is one of the emerging research field in the biological sciences.

Objectives of the study:

1.   To find out year wise distribution of nanotechnology publication.

2.   To find out type of documents in nanotechnology.

3.   To examine the application of Zipf's law in nanotechnology publication.

4.   To find out language wise distribution of nanotechnology.

5.   To examine top 50 journals in the field of nanotechnology.

Material and Methodology:

Web of science was used to extract the reliable literature for nanotechnology by using the nanotechnology as a major main heading from the year 2000 to 2016 . We restricted our search to nanotechnology in terms of publication source name. obtained 10 years of data (2000-2016) of nanotechnology are analyzed through the parameters of document types, publication output, language wise distribution, most productive author and most productive journal etc. Extracted data from the data base and analyzed downloaded data using Histcite.

Data analysis and distribution

Table 1: year wise distribution of articles

| Year	No of Recodes	Cum Records	%	cum %	Average Growth Rate	Descriptive statistics	
2000	30	30	0.376364	0.376364		Range	1030
2001	82	112	1.028729	1.405093	0.365854	Minimum	30
2002	100	212	1.254548	2.659641	0.82	Maximum	1060
2003	174	386	2.182913	4.842554	0.574713	Mean	468.8824
2004	215	601	2.697278	7.539832	0.809302	Std. D	315.5869
2005	272	873	3.41237	10.9522	0.790441	Variance	99595.11
2006	336	1209	4.21528	15.16748	0.809524		
2007	390	1599	4.892736	20.06022	0.861538		
2008	433	2032	5.432192	25.49241	0.900693		
2009	466	2498	5.846192	31.3386	0.929185		
2010	533	3031	6.686739	38.02534	0.874296		
2011	657	3688	8.242379	46.26772	0.811263		
2012	654	4342	8.204742	54.47246	1.004587		
2013	749	5091	9.396563	63.86902	0.873164		
2014	843	5934	10.57584	74.44486	0.888493		
2015	977	6911	12.25693	86.70179	0.862845		
2016	1060	**7971**	**13.29821**	**100**	**0.811727**		
Total	**7971**						
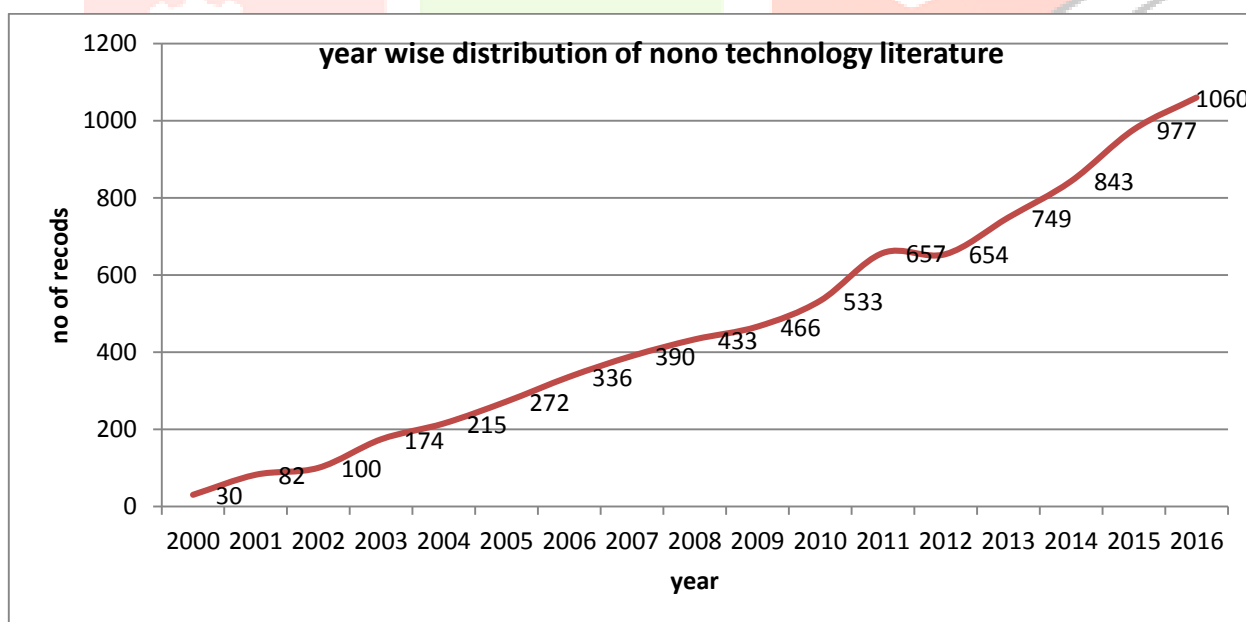
Table 1 shows the growth of research publications published in web of science online database during the study period 2000 to 2016. Altogether there are 7971 publications were published. The highest number of articles (1060) was contributed in the year 2016, representing 13.30 percent of total number of articles published in the database in that year It is to be observed that Least number of articles were published in the year 2000 i.e. 30 articles (0.38 percent). Further it was found that, standard deviation of 315.5869 articles. The articles were published in the range of 1030 articles between highest and lowest number of articles during the study period.

Table 2 different types of published documents

1	Article	5781	72.2625
2	Review	1059	13.2375
3	Article; Proceedings Paper	956	11.95
4	Editorial Material	123	1.5375
5	Meeting Abstract	25	0.3125
6	News Item	21	0.2625
7	Review; Book Chapter	21	0.2625
8	Letter	5	0.0625
9	Article; Book Chapter	3	0.0375
10	Correction	3	0.0375
11	Book Review	1	0.0125
12	Review; Retracted Publication	1	0.0125
13	Software Review	1	0.0125
		8000	100

Table 2 reveals that the 13 types of published documents in the subject of nanotechnology , such as; journal article, review , article in conference proceedings , editorial material, meeting abstract , review in book chapters , news item , software review, letter, articles in book chapter, correction, book review, review retracted publication and software review. Among those, 5871 publications were in the form of journal articles, dominated the highest contribution.

Zipf's law: George Kingsley Zipf: George Kingsley Zipf, a noted linguist, tried to examine the field of linguistics from the scientific point of view and discovered three different interesting laws. One of them is that the length of a word is very closely related to the frequency of itsusage - the greater the frequency, the shorter the word (Zipf, 1935). Zipfs Law and Writings in LIS pattern of an author. For the study, it has been assumed that the changes in the frequency of the use of words during the editorial process is minimal and does not affect the overall result. From this nanotechnology literature doesn't follow Zipf's law.

Zipf's (1949) developed and extended an empirical law, as observed by Estoup governing a relation between the rank of a word and the frequency of its appearance in a long text.

Zipf's Law can be stated as follows

$$Z = \frac{r}{f}$$

Where ' r' is the rank of a word, 'f' is its frequency and 'c' is a constant.

In a long textual matter, if words are arranged in their decreasing order of frequency, then the rank of any given word of the text will be inversely proportional to the frequency of occurrence of the word.

rank	words	frequency	Constant	%
1	NANO	2460	2460	8.393899
2	TECHNOLOGY	738	1476	2.51817
3	USING	674	2022	2.299792
4	BASED	632	2528	2.156481
5	MICRO	542	2710	1.849388
6	PROPERTIES	395	2370	1.347801
7	APPLICATIONS	387	2709	1.320504
8	HIGH	372	2976	1.269321
9	FABRICATION	335	3015	1.143072
10	NANOPARTICLES	322	3220	1.098714
11	SURFACE	319	3509	1.088477
12	MATERIALS	304	3648	1.037295
13	SYNTHESIS	301	3913	1.027058
14	ANALYSIS	278	3892	0.948579
15	CARBON	267	4005	0.911045
16	EFFECT	261	4176	0.890572
17	CHARACTERIZATION	260	4420	0.88716
18	SCALE	260	4680	0.88716
19	SILICON	249	4731	0.849626
20	NOVEL	235	4700	0.801856

Occurance of word of frequency
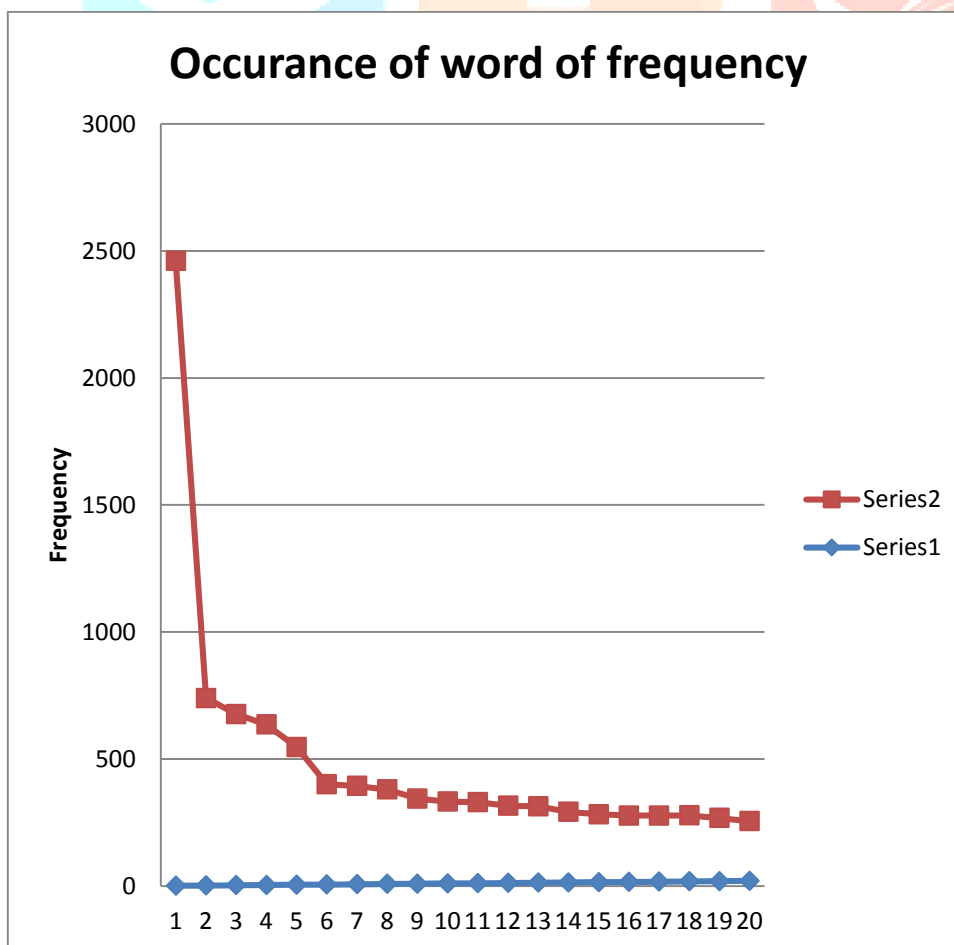
Top 50 Authors				
Sl no	Name of the author	no of papers	%age	Cum%age
1	Wang J	51	4.78	4.78
2	Li J	37	3.47	8.26
3	Li Y	35	3.28	11.54
4	Liu Y	33	3.10	14.63
5	Wang L	32	3.00	17.64
6	Lee JH	31	2.91	20.54
7	Zhang L	31	2.91	23.45
8	Zhang Y	31	2.91	26.36
9	Li L	30	2.81	29.17
10	Lee J	29	2.72	31.89
11	Wang H	29	2.72	34.62
12	Wang Y	29	2.72	37.34
13	Zhang J	26	2.44	39.77
14	Kim J	24	2.25	42.03
15	Wang X	24	2.25	44.28
16	Yang Y	23	2.16	46.44
17	Kim JH	22	2.06	48.50
18	Liu J	22	2.06	50.56
19	Zhang X	22	2.06	52.63
20	[Anonymous]	22	2.06	54.69
21	Lee H	20	1.88	56.57
22	Wang C	20	1.88	58.44
23	Kim Y	19	1.78	60.23
24	Li X	19	1.78	62.01
25	Chen L	18	1.69	63.70
26	Zhang H	18	1.69	65.38
27	Zhang W	18	1.69	67.07
28	Kim H	17	1.59	68.67
29	Liu B	17	1.59	70.26
30	Liu XY	17	1.59	71.86

31	Zhao Y	17	1.59	73.45
32	Kim S	16	1.50	74.95
33	Lee SH	16	1.50	76.45
34	Park J	16	1.50	77.95
35	Yang J	16	1.50	79.46
36	Zhu J	16	1.50	80.96
37	Chen X	15	1.41	82.36
38	Lee CS	15	1.41	83.77
39	Li H	15	1.41	85.18
40	Wang JX	15	1.41	86.59
41	Wang XH	15	1.41	87.99
42	Zhang Z	15	1.41	89.40
43	Zhu B	15	1.41	90.81
44	Chen J	14	1.31	92.12
45	Kim HJ	14	1.31	93.43
46	Kim K	14	1.31	94.75
47	Park SH	14	1.31	96.06
48	Wang YL	14	1.31	97.37
49	Xu J	14	1.31	98.69
50	Yang H	14	1.31	100.00
		1066	100	

The top 50 authors have been listed down on the basis of publishing maximum no. of publications. Out of the 50 authors, it was revealed that Wang J hales from Israel. Published 51 (4.78%) publications. Secondly Li J 37(3.47) and Li Y 35(3.28%) are closely associated with each other

Language wise Distribution				
Sl no	Language	No of records	LCS	GCS
1	English	7655	2488	147859
2	Chinese	223	15	549
3	Japanese	48	1	40
4	German	24	1	58
5	Russian	11	0	52
6	French	9	0	16
7	Korean	7	2	21
8	Polish	5	0	2
9	Spanish	5	0	3

10	Ukrainian	4	0	5
11	Portuguese	3	0	10
12	Croatian	1	0	12
13	Hungarian	1	0	2
14	Italian	1	0	1
15	Lithuanian	1	0	1
16	Serbo-Croatian	1	0	0
17	Turkish	1	0	0

The total research publications (8000) on nanotechnology were published in the seventeen different languages. Among them English language publications wee the maximum literature output with a record count of 7655 with citation count of 147859 as global citation score and 2488 local citation score . Chinese language literature were in the second highest contributor to the field nanotechnology with the score 223 publications with 549 global citation score and 15 as local citation score.

Journals				
	Name of the Journal	Records	%age	cum % age
1	MICROELECTRONIC ENGINEERING	141	6.328546	6.328546
2	ADVANCED POWDER TECHNOLOGY	123	5.520646	11.84919
3	JOURNAL OF NANOSCIENCE AND NANOTECHNOLOGY	116	5.206463	17.05566
4	APPLIED SURFACE SCIENCE	81	3.635548	20.6912
5	SCIENTIFIC REPORTS	81	3.635548	24.32675
6	RSC ADVANCES	68	3.052065	27.37882
7	SURFACE & COATINGS TECHNOLOGY	67	3.007181	30.386
8	MATERIALS LETTERS	60	2.692998	33.07899
9	NANOSCALE	60	2.692998	35.77199
10	NANOTECHNOLOGY	59	2.648115	38.42011
11	JOURNAL OF MICROMECHANICS AND MICROENGINEERING	58	2.603232	41.02334
12	JOURNAL OF NANOPARTICLE RESEARCH	56	2.513465	43.5368
13	OPTICS EXPRESS	55	2.468582	46.00539
14	RARE METAL MATERIALS AND ENGINEERING	49	2.199282	48.20467
15	THIN SOLID FILMS	47	2.109515	50.31418
16	ACS NANO	46	2.064632	52.37882

17	SCIENTIA IRANICA	44	1.974865	54.35368
18	APPLIED PHYSICS LETTERS	43	1.929982	56.28366
19	ACTA PHYSICA SINICA	40	1.795332	58.07899
20	JAPANESE JOURNAL OF APPLIED PHYSICS	38	1.705566	59.78456
21	JOURNAL OF APPLIED PHYSICS	38	1.705566	61.49013
22	JOURNAL OF COMPUTATIONAL AND THEORETICAL NANOSCIENCE	38	1.705566	63.19569
23	SENSORS AND ACTUATORS B-CHEMICAL	38	1.705566	64.90126
24	BIOMATERIALS	34	1.526032	66.42729
25	JOURNAL OF ALLOYS AND COMPOUNDS	34	1.526032	67.95332
26	MICROSYSTEM TECHNOLOGIES-MICRO- AND NANOSYSTEMS-INFORMATION STORAGE AND PROCESSING SYSTEMS	34	1.526032	69.47935
27	NUCLEAR INSTRUMENTS & METHODS IN PHYSICS RESEARCH SECTION B-BEAM INTERACTIONS WITH MATERIALS AND ATOMS	34	1.526032	71.00539
28	ELECTROCHIMICA ACTA	33	1.481149	72.48654
29	SENSORS AND ACTUATORS A-PHYSICAL	33	1.481149	73.96768
30	CHEMICAL ENGINEERING JOURNAL	32	1.436266	75.40395
31	JOURNAL OF MATERIALS SCIENCE	31	1.391382	76.79533
32	JOURNAL OF THE KOREAN PHYSICAL SOCIETY	31	1.391382	78.18671
33	MATERIALS SCIENCE AND ENGINEERING A-STRUCTURAL MATERIALS PROPERTIES MICROSTRUCTURE AND PROCESSING	31	1.391382	79.5781
34	BIOSENSORS & BIOELECTRONICS	30	1.346499	80.9246
35	INTERNATIONAL JOURNAL OF PHARMACEUTICS	30	1.346499	82.2711
36	JOURNAL OF MATERIALS SCIENCE & TECHNOLOGY	30	1.346499	83.61759
37	ANALYTICAL CHEMISTRY	29	1.301616	84.91921
38	INTERNATIONAL JOURNAL OF NANOTECHNOLOGY	28	1.256732	86.17594
39	MICROELECTRONICS RELIABILITY	28	1.256732	87.43268
40	PROGRESS IN CHEMISTRY	28	1.256732	88.68941

41	MICROELECTRONICS JOURNAL	27	1.211849	89.90126
42	SCIENTOMETRICS	27	1.211849	91.11311
43	JOURNAL OF POWER SOURCES	26	1.166966	92.28007
44	SENSORS	26	1.166966	93.44704
45	IEEE TRANSACTIONS ON ELECTRON DEVICES	25	1.122083	94.56912
46	JOURNAL OF MATERIALS CHEMISTRY	25	1.122083	95.6912
47	ADVANCED DRUG DELIVERY REVIEWS	24	1.077199	96.7684
48	APPLIED PHYSICS A-MATERIALS SCIENCE & PROCESSING	24	1.077199	97.8456
49	CHEMICAL SOCIETY REVIEWS	24	1.077199	98.9228
50	JOURNAL OF APPLIED POLYMER SCIENCE	24	1.077199	100
		2228	100	

Indicates that the most productive journals in the field of nanotechnology are three. 17.04 % of world's share was published in these journals(Microelectronic Engineering, Advanced Powder Technology and Journal of Nanoscience and Nanotechnology). The 10 top journal in table shared 39 % of total world's publications through the period of study.

Conclusion:

Nanotechnology is emerging subject day by day most of the research happens in this subject The highest number of articles contributed in the nanotechnology was featured in the year 2016, while lowest number of articles was featured in the year 2000 i.e. 30 articles (0.38 percent). With this result, it is observed that the number of articles contributed to the nanotechnology literature started increasing from the year 2000. Among thirteen types of documents, 5871 publications were in the form of journal articles dominated the highest contribution. The top 50 authors have been listed down on the basis of publishing maximum no. of publications. Out of the 50 authors, it was revealed that Wang J. Published 51 (4.78%) publications. The total research publications (8000) on nanotechnology were published in the seventeen different languages. Among them English language publications wee the maximum literature output with a record count of 7655 with citation count of 147859 as global citation score and 2488 local citation score, where Chinese is second highest . The most productive journals in the field of nanotechnology are three. 17.04 % of world's share was published in these journals namely Microelectronic Engineering, Advanced Powder Technology and Journal of Nanoscience and Nanotechnology. The 10 top journals in table shared 39 % of total world's publications through the period of study.

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