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Scientometric analysis of Spice research publications in India from SCOPUS database during 2010- 2019

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Abstract

This paper presents the scientometric analysis of Spice research publications in India from SCOPUS database during 2010 - 2019 with 3120 research publications. During the Study period, maximum of 400(12.82%) research publications are contributed in the year 2018 and 2019, average research publication per year is 312 and CAGR is 8.62. Relative growth rate is 0.92 in the year 2011 and 0.14 in the year 2019, at the same time doubling time is 0.75 in the year 2011 and 5.05 in the year 2019. Out of 3120 research publications, 179(5.74%) publications are contributed by single author's publications and remaining 2941(94.26%) research publications are multi authors publications. The average degree of collaboration is 0.94. From this study, maximum of 91 (2.92%) research publications are contributed by Pandey, N, maximum of 38(1.22%) research publications are contributed by Analog Integrated Circuits and Signal Processing and maximum of 113(3.62%) publications are produced by Delhi Technological University. Maximum number of 48(1.54%) publications are funded by University Grants Commission. Bradford's Law of Scattering study identified from Zone 1, 40(5.43%) journals were most prolific with 624(32.91%) research publications. The Collaborating countries in India, maximum of 119(3.81%) publications are contributions by United States and Indian authors are collaborated 62 countries with 480 research publications. Time series analysis study found that Spice research publications in Indian in the year 2025 is around are equal to 520 publications and the year 2030 is around are equal to 627 publications and this study confirmed Spice research publications in India is increasing trend.

Keyword: Scientometric, Bibliometric, Spice, Degree of Collaboration, Relative growth Rate and doubling time, Bradford's Law.

Introduction: Spices

Indian are crowned as the pioneers in the knowledge of spices and have been supplying these valuable food processing agents for over 3500 years, Traders, warriors and explores from various parts of the world brought their valuable merchandise in the form of gold. Silver, textiles and exchanged them for Indian spices. Malabar on the west coast has been known as a spice's kingdom. Condiments are processed spices and used in curries etc.

Uses of Spices

Spices are mostly used as flavoring agents in number of foodstuffs, such us curries, bakery products, pickles, processed meats, beverages, liquors etc. they prevent food spoilage due to the action of microorganisms, help quick digestion of the food, create a cooling sensation in the body due to their diaphoretic action, excite sex centres and keep the urine sterile when they are used moderately. Excessive use of spices cause irritability in gastro-intestinal and urinary tract, therefore, they are a contra-indicated in their respective diseases. Also, they should not be used in gall-bladder diseases and gout.[1] Spices are products of plant origin for seasoning food to give flavour and/or aroma. Spices are used for various purposes and besides seasoning food; are used in perfumery, cosmetics and medicines. The Spices Board of the Government of India has categorized the spices into 52 kinds and five broad categories in terms of their origin and features. The categories include major, seed, tree, herbal and others. The 52 spices are distributed amongst these categories [2].

Asian countries are the major producers, marketers and consumers of spices in the world. Trade and commercial activities centred on spices have largely promoted the socio-economic profile of these countries, even leading to European colonization of the east. Hence, it is assumed that this region may be leading in the R&D activities on this product. So that this scientometric study conduct to identify the current status of research activities in the field of spice research in India for the selected ten year study period.

Scientometrics

There are some important bibliometric studies done on Indian contributions to various fields. Rajendran and Parihar (2007) [3] presented a bibliometric study of Laser literature in India for 1995-2005. Ramakrishnan and Ramesh Babu (2007) [4] studied bibliometric analysis of literature on Hepetitis for the period 1984-2003. Sangam and Meera (2008) [5] describe the research collaboration pattern in Indian contributions to Chemical Sciences. Amudhavalli and Florence (2001) [6] presented a profile on Indian productivity in Human Nutrition. Senthilkumaran and Vadivel (2003) [7] presented a bibliometric study on Indian Spices. Amudhavalli and Senthilkumaran (2007) [8] have made cross national comparison of Spices research amongst the Asian countries over a period 1968-2002. Sooryamorthy (2009) [9] shows that collaboration research in South Africa has been growing steadily and the scientists are highly oriented towards collaborative research. Manuelraj and Amudhavalli (2008) [10] studied the literature on health science and found very high degree of collaboration but correlation amongst the productivity and collaboration is low.

Scientists and research scholars, especially those affiliated to some research institutes, usually disseminate the results of their projects in the form of published material, may be journals, conference proceedings, annual reports, bulletins, thesis, etc. So, the research publications are major or most significant indicator of productivity. The productivity of any country's research can be measured by using various bibliometric techniques like year-wise growth and distributions, relative growth rate and doubling time, authorship pattern, degree of collaboration and the contribution of top 10 authors, journals, institutions, Bradford's Law of Scattering and international collaborating countries in India.

Review of related literature

Navasakthi C and Suresh B (2013)[11] analyzed authorship pattern of coffee plantation research in India from 2000 to 2012 with 1231publications and 11.66% of global share. Multiple authors formed 48% of the total research output, while double authorship formed 19.43%. Single authorship had a score of 32.57%

which was smaller in number when compared to the other types. Degree of collaboration had an initial value of 0.63 in the years 2005 and 2006 and 0.71 in the year 2012. The research literature output in Coffee Plant during the period of coverage was found to be in 23 languages among which english was predominant with 92.988%.

Senthilkumaran P and Amudhavalli A. (2017)[12] analyzed the mapping of spices research in Asian countries R&D output on 'Spices' research between 1983 and 2002 from the source database of Hort CD. On these premises, the frequency of keywords found in the descriptor field of each record in the chosen database. Mapping technique is adopted for analysis using Data and Text Mining (DTM) software. The study enabled to correlate the countries versus the subject priority amongst the Asian countries during the study period.

Vivekanandhan S, Rajendran p and Sivasamy K (2019)[13] analyzed the pollution control research publications by Indian contributions from the Scopus online database between 2007 and 2018 with 33084 research publications. Out of that, 1997 publications are contributed by India. During the study period, maximum of 226(0.68%) publications are contributed in the year 2018. The relative growth rate was found that, 0.61 to 0.12 between 2007 and 2018, at the same time doubling time values are 1.14 to 5.77. During the period 607 Indian authors research publications are collaborated by 69 other countries. Maximum of 112(5.61%) publications are collaborated by United States. The average degree of collaboration was 0.92, average collaborative coefficient was 0.61 and average collaborative index was 0.30.

Tripathi, Harish Kumar and Garg K C (2014)[14] analysis the Indian crop science research publications from Scopus, CABI and ISA databases between 2008 and 2010. The study analysis indicates that highest number of papers was published on rice and wheat crop. Agricultural universities and institutions under the aegis of Indian Council of Agricultural Research (ICAR) were most productive institutions. Most of the papers were published in Indian journals with low impact factor. Environment and Ecology, Indian Journal of Agricultural Sciences and Research on Crops were the most preferred journals used by the Indian scientists. The authorship pattern reveals that co-authored papers are dominated maximum of 72% of total output.

Objectives of the Study

1. To find out the year wise growth of spice research publications in Global and India
2. To study the relative growth rate and doubling time
3. To analyze the authorship pattern and degree of collaboration
4. To find out the most productive authors, journals, institutions and funding agencies
5. To test the Bradford's Law of Scattering
6. To identify the international collaborating countries in India
7. To test the time series analysis

Limitations

This study restricted to Spice Research Publications in India for 10 years study period from 2010 to 2019 from SCOPUS multidisciplinary online database and data has been extracted from the following search

keyword: (TITLE-ABS-KEY "Spice" AND PUBYEAR > 2009 AND PUBYEAR < 2020 AND AFFILCOUNTRY("India")).

Methodology

A total number of 3120 publications related to the spice research in India were retrieved and extracted for further analysis. The extracted data has been processed and analyzed using MS-Excel. The following scientometric techniques such as relative growth rate, doubling time, authorship pattern and degree of collaboration, Bradford's Law of scattering and time series analysis were identified from this study.

Data Analysis and Interpretation

Global wise Growth of Spice Research Publications and share of India

Table 1 Global wise Growth of Spice Research Publications and share of India

S. No	Year	No of Publications in Global	%	Indian Publications	Share %
1	2010	1467	7.87	175	11.93
2	2011	1802	9.67	253	14.04
3	2012	1803	9.68	265	14.70
4	2013	1671	8.97	265	15.86
5	2014	1792	9.62	284	15.85
6	2015	1818	9.76	301	16.56
7	2016	2001	10.74	379	18.94
8	2017	2028	10.88	398	19.63
9	2018	2093	11.23	400	19.11
10	2019	2157	11.58	400	18.54
Total		**18632**	**100.00**	**3120**	**16.75**

Table 1 shows that, comparison between global and India's research publications in spice research during the study period of 2010 to 2019, with a total number of 18632 research publications are contributed by global level. Out of that, maximum of 2157(11.58%) publications are contributed in the year 2019, followed by 2093(11.23%) publications in the year 2018. It is identified from the table 1, during the ten year study period India's contribution is 3120(16.75%) research publications.

Year wise Growth of Publications

Table 2 Year wise Growth of Spice Research Publications in India

S. No	Year	No of Publications	%	Cum.	%	Growth Rate
1	2010	175	5.61	175	5.61	
4	2011	265	8.49	440	14.10	1.51
3	2012	265	8.49	705	22.60	1.00
2	2013	253	8.11	958	30.71	0.95

5	2014	284	9.10	1242	39.81	1.12
6	2015	301	9.65	1543	49.46	1.06
7	2016	379	12.15	1922	61.60	1.26
8	2017	398	12.76	2320	74.36	1.05
10	2018	400	12.82	2720	87.18	1.01
9	2019	400	12.82	3120	100.00	1.00
Total		3120	100.00			
CAGR		8.62				

Table 2 shows that, year wise growth of spice related research publications in India from Scopus online database during 2010-2019. It is identified from the study, total number of 3120 research publications are contributed in India during the study period. Out of that, maximum of 400(12.82%) research publications are contributed in the year 2018 and 2019, followed by 398(12.76%) research publications in the year 2017. Average research publications per year is 312. During the study period it is identified that, compound annual growth rate is 8.62. And also, this study found that, maximum annual growth rate is 1.51 in the year 2011, followed by 1.26 in the 2016. Minimum growth rate during the study period is 0.95 in the year 2013.

Relative Growth Rate and Doubling Time

Growth Rate of Publications

The growth of publications was analyzed by using two parameters namely Relative Growth Rate and Doubling time using the Mahapatra (1985)[15] formula. RGR is measure the increases in number of articles in a particular period of time. It is calculated as

$$R(a) = \frac{(W2 - W1)}{(T2 - T1)}$$

Where as
Explain W_1, W_2, T_1 and T_2

R (a) = RGR = the mean relative growth rate over the specific period of interval
W_1 = the logarithm of beginning number of publications/pages
W_2 = the logarithm of ending number of publications/pages after a specific period of interval
$T_2 - T_1$ = the unit difference between the beginning time and the ending time.

Doubling time is the time taken for the doubling of the number of records actually published within a stipulated period. Doubling time is calculated from the relative growth rate and the natural logarithm number is used, the difference has a value of 0.693. Thus, the corresponding doubling time can be calculated by the following formula,

$$Dt = \frac{0.693}{R(a)}$$

Table 3 Relative Growth Rate and Doubling Time

S. No	Year	No of Publications	Cum.	W_1	W_2	RGR = (W_2-W_1)	Dt = 0.693/RGR
1	2010	175	175		5.16		
2	2011	265	440	5.16	6.09	0.92	0.75
3	2012	265	705	6.09	6.56	0.47	1.47
4	2013	253	958	6.56	6.86	0.31	2.26
5	2014	284	1242	6.86	7.12	0.26	2.67
6	2015	301	1543	7.12	7.34	0.22	3.19
7	2016	379	1922	7.34	7.56	0.22	3.16
8	2017	398	2320	7.56	7.75	0.19	3.68
9	2018	400	2720	7.75	7.91	0.16	4.36
10	2019	400	3120	7.91	8.05	0.14	5.05

The relative growth rate (RGR) and the doubling time (Dt) were calculated and the results are presented in table 3. From the study, it is identified from the table 3, the relative growth rate is 0.92 in the year 2011 and 0.14 in the year 2019. It is observed from the study, the relative growth rate by the year wise publications are identified decreasing trend between 2010 and 2019. At the same time, doubling time values from 0.75 in the year 2011 and 5.05 in the year 2019 and it is identified as increasing trend from 2010 to 2019.

Table 4 Authorship Pattern

Authorship Pattern							
Years	1	2	3	4	5	>5	Total
2010	19	49	48	32	12	15	175
2011	16	79	81	49	22	18	265
2012	13	89	65	36	30	32	265
2013	22	68	59	40	27	37	253
2014	20	74	90	49	22	29	284
2015	14	101	87	48	25	26	301
2016	14	121	93	67	38	46	379
2017	26	114	96	67	40	55	398
2018	25	135	103	65	38	34	400
2019	10	103	121	68	42	56	400
Total	**179**	**933**	**843**	**521**	**296**	**348**	**3120**
%	5.74	29.90	27.02	16.70	9.49	11.15	100.00

Table 4 identified that, year wise authorship pattern in the field of Spice research publications in India during the ten years study period. From the study, it is identified that, out of 3120 research publications, 179(5.74%) research publications are contributed by single author's publications and remaining 2941(94.26%) research publications are multi author's publications. From the multi authors publications, maximum of 933(29.9%) research publications are contributed by two authors, followed by 843(27.02%)

publications are contributed by three authors, 521(16.70%) publications are four authors. During the ten years study period more than five authors are contributed 348(11.15%) research publications.

Degree of Collaborations

Degree of collaboration is relationship between single authors and multiauthors contribution. The degree of collaboration is calculated by the Subramanian (1983)[16] formula, used by, Vivekanandhan (2016), [17] Sivasamy (2020).[18]

$$DC = \frac{Nm}{(Nm + Ns)}$$

Where DC = Degree of Collaboration

N_m = Number of multi authored publications

N_s = Number of single authored publications

Table 5 Degree of Collaboration

Years	Single Authors Publications (Ns)	Multi Authors Publications (Nm)	No of Publications	Degree of Collaboration $DC=N_M/(N_M+N_S)$
2010	19	156	174	0.89
2011	16	249	265	0.94
2012	13	252	265	0.95
2013	22	231	253	0.91
2014	20	264	284	0.93
2015	14	287	301	0.95
2016	14	365	379	0.96
2017	26	372	398	0.93
2018	25	375	400	0.94
2019	10	390	401	0.98
Total	**179**	**2941**	**3120**	**0.94**

In the present study, Nm = 2941, Ns= 179

So that the degree of collaboration is =2941/ (179+2941) = 0.94

Table 5 shows that, the degree of collaboration in Spice research publications in India for the selected ten years study period. From this study, it is identified that, the degree of collaboration is between 0.89 in the year 2010 and 0.98 in the year 2019. The average degree of collaboration is 0.94. From this study it is identified that, majority of spice research publications in India is collaborative publications.

Top 10 Authors Contributions

Table 6 Top 10 Authors Contributions

S. No	Name of the Author	No of Publications	% of 3120

1	Pandey, N.	91	2.92
2	Kar, R.	51	1.63
3	Gupta, M.	44	1.41
4	Pandey, R.	42	1.35
5	Paul, S.K.	38	1.22
6	Srinivasan, K.	37	1.19
7	Islam, A.	34	1.09
8	Maheshwari, S.	33	1.06
9	Chaturvedi, B.	30	0.96
10	Chauhan, Y.S.	30	0.96
Total		**430**	**13.78**

Table 6 shows that, top ten authors contributions in the field of spice research publications in India. During the study period it is identified that, maximum number of 91 (2.92%) research publications are contributed by Pandey, N, followed by Kar, R. with 51 (1.63%) research publications, Gupta, M. with 44 (1.41%) research publications. From this study, it is identified that top 10 authors are contributed 430(13.78%) research publications in the field of spice research publications in India.

Top 10 Journals Contributions

Table 7 Top 10 Journals Contributions

S. No	Name of the Journals	No of Publications	% of 3120
1	Analog Integrated Circuits and Signal Processing	38	1.22
2	Journal of Circuits Systems and Computers	35	1.12
3	Lecture Notes in Electrical Engineering	31	0.99
4	Advances in Intelligent Systems and Computing	27	0.87
5	Communications in Computer and Information Science	27	0.87
6	IET Circuits Devices and Systems	25	0.80
7	IEEE Transactions on Electron Devices	24	0.77
8	International Journal of Pharma and Bio Sciences	24	0.77
9	Research Journal of Pharmacy and Technology	24	0.77
10	Handbook of Herbs and Spice Second Edition	21	0.67
Total		**276**	**8.85**

Table 7 identified the top 10 Journals contributions in the field of spice research publications in India. From the table 7, it is identified that, maximum of 38(1.22%) research publications are contributed by Analog Integrated Circuits and Signal Processing, followed by Journal of Circuits Systems and Computers 35(1.12%) and Lecture Notes in Electrical Engineering with 31(0.99%) research publications. During the ten years study period, top 10 journals are contributed 276(8.85%) research publications in spice research.

Top 10 Institution Contributions

Table 8 Top 10 Institution Contributions

S. No	Name of the Institution	No of Publications	% of 3120
1	Delhi Technological University	113	3.62
2	Central Food Technological Research Institute India	94	3.01
3	Aligarh Muslim University	81	2.60
4	Netaji Subhas Institute of Technology	68	2.18
5	Council of Scientific and Industrial Research India	65	2.08
6	Jadavpur University	65	2.08
7	National Institute of Technology, Durgapur	62	1.99
8	ICAR - Indian Institute of Spices Research, Kozhikode	61	1.96
9	Jamia Millia Islamia	61	1.96
10	Jaypee Institute of Information Technology	55	1.76
	Total	**725**	**23.24**

During the ten years study period, top 10 institutions research contributions in spice research in India were shows in table 8. From this study, it is identified that maximum of 113(3.62%) publications are contributed by Delhi Technological University, followed by Central Food Technological Research Institute India contributed with 94(3.01%) research publications, Aligarh Muslim University contributed with 81(2.60%) research publications. Top 10 institutions are contributed 725(23.24%) research publications in spice research publications in India for the selected ten year study period.

Top 10 Funding Agencies

Table 9 Top 10 Funding Agencies Contributions

S. No	Name of the Funding Agency	No of Publications	% of 3120
1	University Grants Commission	48	1.54
2	Bangladesh Council of Scientific and Industrial Research	38	1.22
3	Department of Science and Technology, Government of Kerala	35	1.12
4	Department of Biotechnology, Government of West Bengal	34	1.09
5	Indian Council of Medical Research	22	0.71
6	Science and Engineering Research Board	22	0.71
7	Indian Council of Agricultural Research	20	0.64
8	Department of Science and Technology, Ministry of Science and Technology, India	19	0.61
9	Ministry of Electronics and Information technology	18	0.58
10	University Grants Committee	18	0.58
	Total	274	8.78

During the ten years study period, top ten funding agencies are identified and listed in the table 9. From the study, it is identified that, maximum of 48(1.54%) research publications are funded by University Grants Commission, followed by Bangladesh Council of Scientific and Industrial Research with 38(1.22%) research publications and Department of Science and Technology, Government of Kerala contributed with

35(1.12%) research publications. Top ten funding Agencies are funded 274(8.78%) research publications in the field of spice research publications in India for the selected ten year study period.

Source types of Publications

Table 10 Source types of spice research publications in India

S. No	Source Type	No of Publications	%
1	**Journal**	**1896**	**60.77**
2	Conference Proceeding	903	**28.94**
3	Book	179	**5.74**
4	Book Series	138	**4.42**
5	Trade Journal	4	**0.13**
	Total	3120	**100.00**

Table 10 shows the source types of spice research publications in India. From the table 10, it is identified that maximum number of 1896(60.77%) publications are produced by journals. Followed by 903(28.94%) publications are identified conference proceedings, 179(5.74%) publications are books, 138(4.42%) publications are book series and 4(0.13%) publications are trade publications.

Bradford's Law of Scattering

The main aim of Bradford's Law Scattering[19] is to explain the group of core journals of a particular discipline could be arranged in the order of decreasing productivity of publications. According to Bradford's law, the journals are grouped into three zones with equal number of publications. However the number of journals in each zone will be increase rapidly. Then the relationship between the zones are $1:n:n^2$.

Table 11 Bradford's Law of Scattering

S.No	Zone's	No of Journals	%	No of Publications	%
1	Zone 1	40	5.43	624	32.91
2	Zone 2	159	21.57	631	33.28
3	Zone 3	538	73	641	33.81
Total		**737**	**100**	**1896**	100.00

Here Calculate the Multiplier

159/40=3.98

538/159 = 3.38

(3.98+3.38)/2 = 7.36/2 = 3.68

Bradford's Law Formula is $1:n:n^2$

Here,   40 : 40 X 3.68 : 40 X 3.68^2

As per Bradford's Law   40:147: 542

Table-11 shows that the each zones has approximately one third (1896/3=632) of publications.   It is identified from the through Zone 1, out of 737 journals, 40(5.43%) journals were most prolific with 624(32.91%) research publications. Followed by 159(21.57%) journals were identified into the Zone 2 as more prolific with 631(33.28%) publications. 538(73%) journals were identified in Zone 3 as least prolific with 641(33.81%) publications among the total of 737 journals. From the table-7, it is identified that, the journal distributions as per the Bradford's Law exposes the ratio as 40: 147: 542.

Actual contributions are 40:159:538

Here it is compared to the actual contributions and as per Bradford's Law contributions

40 : 159 : 538 is not equal to 40: 147: 542

It is conformed from this study, the ratio of the number of journal titles in each zone is not increasing gradually. Therefore it is concluded that the distribution of the journal productivity in spice research publications in Indian for the selected ten year study period is not satisfy the Bradford's Law.

Top 10 International Collaborated Countries in India

Table 12 Top 10 International Collaborated countries in India

S. No	Name of the Country	No of Publications	% of 3120
1	United States of America	119	3.81
2	Greece	25	0.80
3	Viet Nam	23	0.74
4	Czech Republic	22	0.71
5	Saudi Arabia	19	0.61
6	Turkey	17	0.54
7	United Kingdom	17	0.54
8	Canada	16	0.51
9	Japan	13	0.42
10	Australia	12	0.38
11	Others 52 Countries	197	6.31
Total		**480**	**15.38**

Table 12 shows that, top 10 international collaborated countries in Indian authors in spice research for the selected ten year study period. From the study, it is identified that, maximum number of 119(3.81%) publications are collaborated by United States of America. Followed by Greece with 25(0.80%) research publications, Viet Nam with 23(0.74%) research publications are collaborated by India. During the ten year study period Indian authors are collaborated by 62 different countries with 480 research publications in spice research.

Time Series Analysis

Time series analysis study reveals that, the estimated growth values are identified based on previous data. A straight –line equation is adapted to measure the future values based on previous data. Time series analysis used by Sivagami N[20] (2016). This study identified the future prediction of wireless sensor network research publications in India for the year 2025 and 2030.

Table 13 Time Series Analysis

S. No	Year	No of Publications (Y)	X	X^2	XY
1	2010	175	-5	25	-875
4	2011	265	-4	16	-1060
3	2012	265	-3	9	-795
2	2013	253	-2	4	-506
5	2014	284	-1	1	-284
6	2015	301	1	1	301
7	2016	379	2	4	758
8	2017	398	3	9	1194
9	2018	400	4	16	1600
10	2019	400	5	25	2000
Total		**3120**	0	110	2333

Straight Line Equation is

$Y = a + bx$

Here,

$\sum Y = 3120, \sum X^2 = 110, \sum XY = 2333, N=10$
$a = \sum Y/N = 3120/10 = 312$

$b = \sum XY/ \sum X^2 = 2333/110 = 21.2 = 21$

Estimate growth of publications in the year 2025 is, when x = 2025-2015 = 10

$Y = a + bx$

$= 312 + (21*10) = 312+210 = 520$

Estimated growth of publications in the year 2030 is, when x = 2030-2015 = 15

$Y = a + bx$

$= 312 + (21*15) = 312 + 315 = 627$

The estimated growth based on a time series analysis statistical application will be expected in spice research publications in Indian in the year 2025 is around are equal to 520 publications and the year 2030 is around are equal to 627 publications. So that time serious analysis study confirmed that spice research publications in India is increasing trend.

Major Findings

- During the study period total number of 3120 research Publications are contributed in India. Out of that, maximum of 400(12.82%) research publications are contributed in the year 2018 and 2019. Average research publications per year is 312 and compound annual growth rate is 8.62.

- Relative growth rate is 0.92 in the year 2011 and 0.14 in the year 2019. This study confirmed that relative growth rate is decreasing trend. At the same time doubling time is found that 0.75 in the year 2011 and 5.05 in the year 2019 and it is conformed that, doubling time is increasing trend.

- Out of 3120 research publications in India, 179(5.74%) research publications are contributed by single author's publications and remaining 2941(94.26%) research publications are multi authors publications. Average degree of collaboration is 0.94.

- During the study period, maximum of 1730(55.45%) research publications are contributed by article, maximum of 91 (2.92%) research publications are contributed by Pandey N, maximum of 38(1.22%) research publications are contributed by Analog Integrated Circuits and Signal Processing, maximum of 113(3.62%) contributions are Delhi Technological University and maximum of 48(1.54%) publications are funded by University Grants Commission.

- Bradford's Law study is identified from Zone 1, out of 737 journals, 40 (5.43%) journals are the most prolific with 624(32.91%) research publications and this study conformed Bradford's Law is not satisfy.

- Maximum of 119(3.81%) research publications are collaborated by United States of America. During the ten year study period Indian authors are collaborated by 62 different countries with 480(15.38%) research publications in spice research.

- Time series analysis study found that spice research publications in Indian in the year 2025 is around are equal to 520 publications and the year 2030 is around are equal to 627 publications. So that, this study confirmed spice research publications in India is increasing trend.

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