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Micro Plastic Pollution Research Output in India from the Scopus Database during 2012-2021: A Scientometric Analysis

***S. Ravichandran, ** Dr. N. Siva, *** P. Ganesh**

*Library Assistant Grade-1, SRM Institute of Science and Technology, Kattankulathur, Chengalpet, Tamilnadu, India. Pin- 603203,
**Deputy Librarian, SRM Institute of Science and Technology, Kattankulathur, Chengalpattu, Tamilnadu, India. Pin: 603203
Assistant Librarian SRM Institute of Science and Technology, Kattankulathur, Chengalpattu, Tamilnadu, India. Pin: 603203,

Abstract

The present study of scientometic analysis of micro plastic pollution research output during the study period 2012 to 2021, the total number of 1679 research publications are contributed. The maximum number of 815(48.54%) publications are contributed in the year. The average research publication per year is 167.9, the compound annual growth rate 75.15. The maximum of 14804 (24.52%), citations are received 534 publications in the year 2020. The RGR is 0.69 in the year 2013 and 0.66 in the year 2021. The RGR is decreasing trend from 2013 to 2020. At the same time, Dt is found that 1.00 in the year 2012 and 1.04 in the year 202.So Dt is increasing trend. The majority of the authorship pattern in more than five authorship mode with 763(45.44%) publications, and the degree of collaboration average is 0.96. The average CC value is 0.69, the average CI value is 4.25, and the average MCC value is 4.75. The authors that, the maximum of 29(18.71%) research publications are contributed by Shi, H. China The study document type that, a maximum of 1336(79.57%) research publications are contributed by Article, The institutions that, the maximum number of 114(21.71%) publications are contributed by Chinese Academy of Sciences, and journals that, a maximum of 276(25.99%) research publications are contributed by Science of the total Environment. The study collaborative country that, a maximum of 545(37.15%) research publications are collaborated by China. The time series analysis of research publications in Indian in the year 2025 is around are equal to 1435 publications and the year 2030 is around are equal to 1818 publications is increasing trend. The highest cited paper of a maximum number of 1040 citations are received by Horton, A.A., et al (2017) Micro plastics in freshwater and terrestrial environments: Evaluating the current understanding to identify the knowledge gaps and future research priorities, Science of the total Environment, 586, 127-141.

Keywords: Authorship pattern, Scientometrics, Time series analysis, Relative growth rate, Degree of collaboration, Collaborative index CC, CI, and MCC, Co-author index.

Introduction

Micro plastics are small pieces of plastic, less than 5 mm (0.2 inches) in length, that occur in the environment as a consequence of plastic pollution. Micro plastics are present in a variety of products, from cosmetics to synthetic clothing to plastic bags and bottles. Many of these products readily enter the environment in waste. Micro plastics consist of carbon and hydrogen atoms bound together in polymer chains. Other chemicals, such as phthalates, polybrominated diphenyl ethers (PBDEs), and tetrabromobisphenol A (TBBPA), are typically also present in micro plastics, and many of these chemical additives leach out of the plastics after entering the environment.

Micro plastics are divided into two types: primary and secondary. Examples of primary micro plastics include microbeads found in personal care products, plastic pellets (or nurdles) used in industrial manufacturing, and plastic fibers used in synthetic textiles (e.g., nylon). Primary micro plastics enter the environment directly through any of various channels—for example, product use (e.g., personal care products being washed into wastewater systems from households), unintentional loss from spills during manufacturing or transport, or abrasion during washing (e.g., laundering of clothing made with synthetic textiles). Secondary micro plastics form from the breakdown of larger plastics; this typically happens when larger plastics undergo weathering, through exposure to, for example, wave action, wind abrasion, and ultraviolet radiation from sunlight.

Micro plastics are not biodegradable. Thus, once in the environment, primary and secondary micro plastics accumulate and persist. Micro plastics have been found in a variety of environments, including oceans and freshwater ecosystems. In oceans alone, annual plastic pollution, from all types of plastics, was estimated at 4 million to 14 million tons in the early 21st century. Micro plastics also are a source of air pollution, occurring in dust and airborne fibrous particles. The health effects of micro plastic inhalation are unknown. By 2018, in marine and freshwater ecosystems combined, micro plastics had been found in more than 114 aquatic species. Micro plastics have been found lodged in the digestive tracts and tissues of various invertebrate sea animals, including crustaceans such as crabs. Fish and birds are likely to ingest micro plastics floating on the water surface, mistaking the plastic bits for food. The ingestion of micro plastics can cause aquatic species to consume less food and therefore to have less energy to carry out life functions, and it can result in neurological and reproductive toxicity. Micro plastics are suspected of working their way up the marine food chains, from zooplankton and small fish to large marine predators.

Micro plastics have been detected in drinking water, beer, and food products, including seafood and table salt. In a pilot study involving eight individuals from eight different countries, micro plastics were recovered from stool samples of every participant. Scientists have also detected micro plastics in human tissues and organs. The implications of these findings for human health were uncertain. Between 1950 and 2015, some 6,300 million metric tons of plastic waste were

generated. The majority of this waste, about 4,900 million metric tons, ended up in landfills and the environment. On the basis of trends from that period, researchers estimated that by 2050 the amount of plastic waste in landfills and the environment would reach 12,000 million metric tons. Nonetheless, the potential dangers of escalating plastics pollution, especially pollution from micro plastics, remained largely ignored by governments and policymakers.[1]

https://www.britannica.com/science/styrene-acrylonitrile-copolymer

Scientometric Study

Scientometric is a study to measure the performance of researchers as well as the research publications. The research activities contain major changes over the last few decades and emerged as an established research in the discipline of "Library and Information Science". The study of scientific literature has a long history dating back to the early decades of the past century. However, despite in the number of research literature in this area it was not until 1969, that the term bibliometrics first appeared in print (**Pritchard 1969**)[2]. Definition of bibliometric was 'application of mathematical and statistical methods to books and other media of communication', particularly in North America, the term was quickly adopted and used **(Wilson, 1999**)[3]. At the same time, **Nalimov and Mulchenko (1969**)[4] coined the term scientometrics to refer to 'the application of quantitative methods which are dealing with the analysis of science viewed as an information process'. In contrast, this term was widely used in Europe **(Wolfram, 2003**)[5.] Initially, therefore, scientometrics was restricted to the measurement of science communication, whereas bibliometrics was designed to deal with more general information processes, **Andres A (2009**)[6.]

Review of Literature

Vivekanandhan et al (2016)[7] analyzed the pollution control research output from the SCOPUS database during the period of 1985-2014. They analyzed his study growth of literature, number of citations and bibliographic distribution. Further they analyzed scientometric tools such as authorship pattern, Citation Index, Collaborative Coefficient, modified collaborative coefficient and block year wise publications. Maximum numbers of 13692 (25.43%) publications are contributed in the 6thblock of 2010 – 2014 and block year wise average degree of collaboration was 0.72.

Sudhakar and Thanuskodi (2018)[8] analyzed the scientometric analysis of Marine Pollution Bulletin Journal research publications from 2008 to 2017 with 5416 publications. Maximum numbers of 905(16.71%) publications are contributed in the year 2017. This study identified RGR has been decreased from 0.63 to 0.18 and the same time doubling time has been increased from 1.10 to 3.85. The degree of collaboration was 0.94, which clearly indicates its dominance of multiple author's contributions. Liu J. was the top ranked authors with 49 articles. Maximum numbers of 910 (12.06%) publications are contributed by United States.

Dhanya and Raja (2017)[9] analyzed the Indian research output of industrial pollution indexed in the Web of Science database with 805 publications during 2007-2016 which received 9699citations. Kumar A and Kumar R are the most productive authors with 13 (1.6%) publications. The most productive journal is Environmental Monitoring and Assessment with 103 (12.8%) publications and the maximum of articles are published in the year 2016 with 113(14%) publications. Relative Growth Rate is 0.16 in the year 2016 and Doubling Time is 4.58 in the year 2016.

Ravichandran and Vivekanandhan (2020)[10] analyzed the solid waste management research publications (2010-2019) using SCOPUS database with 5198 research publications. The study identified that, maximum of 694 (13.35%) research publications in the year 2019, CAGR was 3.67. Maximum of 3907(75.16%) research publications are contributed by article, maximum of 43 (0.83%) research publications are contributed by Huang G.H, India. During the study identified that multi authors are dominated in this study field and average degree of collaboration was 0.88. Relative growth rate was 0.63 in the year 2011 and 0.14 in the year 2019 at the same time doubling time was 1.10 in the year 2011 and 4.84 in the year 2019.

Murugan S et al (2020)[11] analyzes the air pollution research publications are contributed to the SCOPUS online database during the period from 2014 to 2018 with 37394 research publications. During the study period, it is identified that a maximum number of 8723 (23.33%) research publications are contributed in the year 2017, top-ranking author is Koutrakis P with 129 (13.89%) research publications, the maximum of 26997 (72.20 %) research publications are contributed by articles. A maximum of 6035 (16.14 %) publications are contributed by three authors, the average author per paper is 3.82 authors and average paper per author is 0.26 publications, the average degree of collaboration is 0.91 and a maximum of 9042 (29.39%) research publications are contributed by the United States.

Ravichandran and Vivekanandhan (2021)[12] examine the Scientometric analysis of wastewater management research publications during 2010-2019 from Scopus database. The study identified that maximum of 2842(14.31%) research publications with 19857 citations are contributed in the year 2019. Ngo, H.H contributed a maximum of 101(0.51%) research publications, maximum of 19355 articles were contributed by joint authors and average degree of collaboration was 0.97. Maximum of 2102(10.58%) research publications are contributed in Bio resource technology, ministry of education, china with 863(22.32%) research publication and China has contributed maximum of 5919(29.80%) research publications.

Objective of the Study

- To study the year wise growth of micro plastic pollution research publications in India
- To examine the relative growth rate and doubling time.
- To study the authorship pattern.
- To study the degree of collaboration, CC, CI and MCC

- To find out the co-authorship index.
- To identify the top 10 Authors, Institutions, Journals
- To identify the International Collaborated Countries in India
- To examine the time series analysis
- To identify the top 10 keywords and top 10 funding agencies
- To identify the top 10 highly cited publications in India

Research method

This study identified the Leukemia research publications using Scopus multidisciplinary online database from 2011 to 2020. The following search keyword is used to collect the data. The search key is: (TITLE-ABS-KEY ("Micro plastic pollution") AND PUBYEAR > 2011 AND PUBYEAR < 2022) the data was collected for this study is 26.03.2022. The collected data's were analyzed using Micro soft excel work sheet.

Data Analysis and Interpretations

Compound Annual Growth Rate [CAGR]

The Compound Annual Growth Rate [CAGR] is one of the useful measures to identify the growth, over the multiple time periods. It can be measure from the initial number of publications to ending number of publications. The mathematical formula of CAGR is used **Ashok Kumar and Gopala Krishnan (2013)**[13]

The compound annual growth rate was calculated by the following formula,

$$\mathbf{CAGR} = \left[\frac{\mathbf{Ending\ Value}}{\mathbf{Begining\ Value}}\right]^{\left[\frac{1}{\#\ \mathbf{of\ Years}}\right]} - 1$$

During the ten year study period compound annual growth rate is calculated by the Leukemia research outputs in India from the beginning year and ending year. It is identified from the table 1 the compound annual growth rate is 75.15.

Relative Citation Index (RCI)

Relative citation index (RCI) was developed by the Institute of Scientific Information and examine the impact of different countries, institutions, authors and journals research publications. The scientific impact of leading countries was examined by using two relative indicators, namely citations per paper (CPP) and relative citations index (RCI). Citations per paper (CPP) are a relative indicator computed as the average number of citation per paper. To measure the both influence and visibility of a country research, the following formula has been used by **Bharvi Dutt and Khaiser Nikam (2016)**[14]

$$\text{RCI} = \frac{\text{A Country share of the World Citations}}{\text{A Country share of the World Publications}}$$

RCI = 1 indicate that a country's citation rate is equal to the world citation rate
RCI > 1 indicate that a country's citation rate is greater than the world citation rate
RCI < 1 indicate that a country's citation rate is lower than the world citation rate

Year Wise Growth of Micro plastic Pollution Research Publication

Table 1 Year Wise Growth of Micro plastic Pollution Research Publication

S.No	year	Publication	%	Citations	%	Cited	%	Uncited	%	h-index	CPP	RCI
1	2012	3	0.18	409	0.68	3	0.20	0	0.00	3.00	136.33	3.79
2	2013	3	0.18	1748	2.89	3	0.20	0	0.00	3.00	582.67	16.20
3	2014	8	0.48	2622	4.34	8	0.52	0	0.00	7.00	327.75	9.11
4	2015	16	0.95	3157	5.23	16	1.04	0	0.00	16.00	197.31	5.49
5	2016	28	1.67	4158	6.89	26	1.69	2	1.35	22.00	148.50	4.13
6	2017	38	2.26	8346	13.82	38	2.47	0	0.00	33.00	219.63	6.11
7	2018	83	4.94	9255	15.33	82	5.34	1	0.68	54.00	111.51	3.10
8	2019	151	8.99	8795	14.57	147	9.56	10	6.76	54.00	58.25	1.62
9	2020	534	31.80	14804	24.52	515	33.51	19	12.84	58.00	27.72	0.77
10	2021	815	48.54	7090	11.74	699	45.48	116	78.38	32.00	8.70	0.24
	Total	1679	100.00	60384	100.00	1537	100.00	148	100.00			
	CAGR	75.15										

Table 1 shows the year-wise growth of micro plastic pollution in India research publications during the 10-year study period between 2012 and 2021 with 1679 research publications and 60384 citations. From the study, it is identified that the maximum of 815 (48.54%) research publications are contributed in the year 2021, followed by 534(31.80%) publications in the year 2020, and 151(8.99%) publications in the year 2019. The average research publication per year is 167.9

During the ten-year study, it is identified that a total number of 1679 publications are received 60384 citations. Out of that maximum of 14804 (24.52%), citations are received 534 publications in the year 2020 Followed by 9255(15.33%) citations are received 83 publications in the year 2018. From the study, out of 1679 publications, 1537(100%) research publications are cited publications, and 148(100%) research publications are uncited publications. The maximum of citation per paper is 582.67 in the year 2013, followed by CPP is 327.75 in the year 2014, and by CPP is 219.63 in the year 2017 and the average citation per paper is 181.837. The maximum of RCI is 16.20 in the year 2013, followed by 9.11 in the year 2014, by 6.11 in the year 2017 and the average RCI is 5.07. The highest h-index is 58.00 in the year 2019, the lowest h-index is 3.00 in the year 2012, 2013. The CAGR is 75.15.

Relative Growth Rate (RGR)

The most important feature of science and technology in recent years has been calculated by the rate of growth. Scientific growth has been involved not only increase in manpower and financial investment. The relative growth rate is identified by the increase in number of publications per unit of time. The mean relative growth rate over the particular period of interval can be calculated in the following formula developed by **Mahapatra (1985)**[15]

$$R(a) = \frac{(W_2 - W_1)}{(T_2 - T_1)}$$

Where,

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.

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

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

Relative Growth Rate and Doubling Time in Micro plastic Pollution Research Publication

Table 2 Relative Growth Rate and Doubling Time in Micro plastic Pollution Research Publication

S.No	Years	Publications	Cum	W1	W2	RGR=(W2-W1)	Dt=(0.693/RGR
1	2012	3	3		1.10		
2	2013	3	6	1.10	1.79	0.69	1.00
3	2014	8	14	1.79	2.64	0.85	0.82
4	2015	16	30	2.64	3.40	0.76	0.91
5	2016	28	58	3.40	4.06	0.66	1.05
6	2017	38	96	4.06	4.56	0.50	1.38
7	2018	83	179	4.56	5.19	0.62	1.11
8	2019	151	330	5.19	5.80	0.61	1.13
9	2020	534	864	5.80	6.76	0.96	0.72
10	2021	815	1679	6.76	7.43	0.66	1.04
	Total	1679					

The relative growth rate and the doubling time (Dt) in micro plastic pollution in India research output is calculate and the results are presented in table 2. From the study it is identified that, the relative growth rate is 0.69 in the year 2013 and 0.66 in the year 2021. This study confirmed that, relative growth rate is decreasing trend from 2013 to 2020. At the same time, doubling time is found that 1.00 in the year 2012 and 1.04 in the year 2021. It is conformed that doubling time is increasing trend during the study period.

Authorship Pattern in Micro plastic Pollution Research Publication

Table 3 Authorship Pattern in Micro plastic Pollution Research Publication

Authorship pattern							
year	**1**	**2**	**3**	**4**	**5**	**>5**	**Total**
2012	1	0	1	1	0	0	3
2013	0	0	0	1	1	1	3
2014	1	1	1	3	0	2	8
2015	2	4	1	0	4	5	16
2016	1	5	3	5	3	11	28
2017	2	4	7	8	4	13	38
2018	2	3	12	16	13	37	83
2019	7	15	20	27	28	54	151
2020	15	50	73	71	70	255	534
2021	28	55	102	110	135	385	815
Total	59	137	220	242	258	763	1679
%	**3.51**	**8.16**	**13.10**	**14.41**	**15.37**	**45.44**	**100.00**

Table 3 indicates the authorship pattern in the field of micro plastic pollution research output in India for the selected ten year study period. From the study it is identified from the table-3, majority of the authors in the field are preferred to publish their research works in more than five authorship mode with 763(45.44%) publications. Followed by five authorship mode with 258(15.37%) publications, four authorship mode with 242(14.41%) publications. During the study period three authors are contributed with 220(13.10%) publications, two authors are contributed only 137(8.16%) publications. single author are contributed only 59(3.51%) publications. This study confirmed that more than 96.49% of publications are contributed in multiple authors.

Degree of Collaboration

The degree of collaboration is relationship between the single author and multi author's contributions. The degree of collaboration is calculated by the **Subramanian formula (1983)[16], used by Ravichandran and Vivekanandhan (2021)[17]**

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

Where DC = Degree of Collaboration

N_m = Number of multi authored publications

N_s = Number of single authored publications

In the present study, Nm = 1620, Ns= 59

So that, the degree of collaboration is =1620/ (59+1620) = 0.96

Degree of Collaboration in Micro plastic Pollution Research Publication

Table 4 Degree of Collaboration in Micro plastic Pollution Research Publication

Year	Single author publications	Multi – author publications	Total author publication	Degree of Collaboration DC = Nm / Ns+Nm
2012	1	2	3	0.67
2013	0	3	3	1.00
2014	1	7	8	0.88
2015	2	14	16	0.88
2016	1	27	28	0.96
2017	2	36	38	0.95
2018	2	81	83	0.98
2019	7	144	151	0.95
2020	15	519	534	0.97
2021	28	787	815	0.97
Total	59	1620	1679	0.96

Table 4 shows that, degree of collaboration in micro plastic pollution research publications in India for the selected ten year studies period. From this study it is identified that, the degree of collaboration is between 0.97 in the year 2012 and 0.97 in the year 2021. The average degree of collaboration is 0.96. From this study it is identified that, majority of micro plastic research publications are contributed by collaborative authors.

Collaborative Coefficient (CC)

The pattern of co-authorship collaboration among the authors can be measured with the following formula suggested by **Ajiferuke et al. (1988)**[18]

$$CC = 1 - \left[\sum_{j=0}^{k} \left(\frac{1}{j}\right) \times Fj/N\right]$$

Whereas,

Fj = Number of publications with j author papers

N = Total number of the research publications and

k = the greatest number of authors/ paper in the given field.

Collaboration Index (CI)

The simple indicator are presently employed in the publications to the collaboration index, which is to be understand nearly as the mean number of authors per paper are suggested by **Ajiferuke et al.(1988)**[18]

$$CI = \frac{\sum_{j=1}^{k} jfj}{N}$$

Here

J - The number of co-authored papers appearing in a discipline

N - The total number of publications in the field over the same time period of interval and

k - The highest number of authors per paper in a same time field.

Modified Collaboration Coefficient

The modified collaboration coefficient (MCC) counted by the formula which is suggested by **Savanur and Srikanth (2010)**[19]

Which is given below:

Where,

$$MCC = \frac{N}{N-1}\left[1 - \frac{\sum_{j=1}^{k} jfj}{N}\right]$$

j = the number authors in an article i.e. 1, 2, 3.....

Fj = the number of j authored articles

N = the total number of articles published in a year, and

A = the total number of authors per articles

Collaborative Measure in Micro plastic Pollution Research Publication

Table 5 Collaborative Measures in Micro plastic Pollution Research Publication

Authorship pattern									
year	**1**	**2**	**3**	**4**	**5**	**>5**	**CC**	**CI**	**MCC**
2012	1	0	1	1	0	0	0.47	2.67	4.00
2013	0	0	0	1	1	1	0.79	5.00	7.50

2014	1	1	1	3	0	2	0.64	3.75	4.29
2015	2	4	1	0	4	5	0.63	3.94	4.20
2016	1	5	3	5	3	11	0.71	4.32	4.48
2017	2	4	7	8	4	13	0.70	4.24	4.35
2018	2	3	12	16	13	37	0.76	4.76	4.82
2019	7	15	20	27	28	54	0.72	4.43	4.46
2020	15	50	73	71	70	255	0.74	4.68	4.69
2021	28	55	102	110	135	385	0.74	4.75	4.75
Total	59	137	220	242	258	763			

Table 5 shows that, collaborative measures of micro plastic pollution research publications in India for the selected ten year study period from 2012 to 2021. From the study it is identified that, it is identified from the table 5, the maximum of collaboration coefficient value is 0.79 in the year 2013, and minimum of collaborative coefficient value is 0.47 in the year 2012. The average collaborative coefficient value is 0.69. The collaboration index values are identified from the table 5, the maximum of collaboration index value is 4.76 in the year 2018 and a minimum of collaboration index value is 2.67 in the year 2012.The average collaboration index value 4.25. The maximum of modified collaborative coefficient value is 4.82, and a minimum of modified collaborative coefficient value is 4.00. The average value is 4.75.

Co-authorship Index (CAI)

To study how the pattern of co-authorship and the use of co-authorship index suggested by **Garg and Padhi (2001)**[20] has been explained the under mentioned formula. To evaluate the co-authorship index (CAI) is the whole set of data is divided into 2 block years.

$$\mathrm{CAI} = \left[\frac{(\mathrm{Nij}/\mathrm{Nio})}{(\mathrm{Noj}/\mathrm{Noo})}\right] \times 100$$

Whereas,
Nij - Number of publications having j authors in i block
Nio - Total publications of i block
Noj - Number of publications having j authors for all blocks
Noo-: Total number of publications for all authors and the all blocks

Here CAI=100 implies that a country's co-authorship effort for a particular authorship correspond to the world average
CAI > 100 reflects higher than average co-authorship effort
CAI < 100 reflects lower than average co-authorship effort by the given type of authorship pattern.

For calculating the co-authorship index for authors, years have been replaced into block years. For this study, the authors have been classified into two blocks (ie.2012-2016 and 2017-2021) Vs**.** Single, Two, Three authors and More than 3 authors.

Co- Authorship Index (CAI) in Micro plastic Pollution Research Publication

Table 6 Co- Authorship Index) in Micro plastic Pollution Research Publication

5 year Block	Single	CAI	Two	CAI	Three	CAI	More than three	CAI	Total
2012-2016	5	245.32	10	211.30	6	78.95	37	84.80	58
2017-2021	54	94.80	127	96.02	214	100.75	1226	100.54	1621
Total	59		137		220		1263		1679

Table 6 shows that, Co-Authorship Index values are calculated by the block year period for micro plastic pollution research publications in India for the selected ten year study period. From the study it is identified that, CAI for single and two authorship contributions are decreasing trend from 1st block year to 2nd block year. At the same time CAI is increasing trend for three authors and more than three authors from 1st block year to 2nd block years (84.80) to (100.54).

Top 10 Authors Contribution in Micro plastic Pollution Research Publication

Table 7 Top 10 Authors Contribution in Micro plastic Pollution Research Publication

S.No	Author	Country	Publications	%	Citations	%	CPP	H-Index	RCI
1	Shi, H.	China	29	18.71	4492	29.22	154.90	24	1.56
2	Wang, J.	United States	19	12.26	1719	11.18	90.47	16	0.91
3	Wu, C.	United Kingdom	17	10.97	1738	11.31	102.24	13	1.03
4	Li, D.	Germany	14	9.03	1869	12.16	133.50	10	1.35
5	Rochman, C.M.	Italy	14	9.03	482	3.14	34.43	9	0.35
6	Huang, W.	India	13	8.39	388	2.52	29.85	10	0.30
7	Su, L.	Spain	13	8.39	2231	14.51	171.62	12	1.73
8	Xiong, X.	Australia	13	8.39	1378	8.96	106.00	10	1.07
9	Wang, Q.	France	12	7.74	574	3.73	47.83	10	0.48
10	Zhao, J.	Canada	11	7.10	501	3.26	45.55	9	0.46
	Total		155	100.00	15372	100.00			

Table 7 identified the top ten author's contribution in micro plastic pollution research publications in India from the Scopus database for the selected ten year study period. From the study it is identified that, maximum of 29(18.71%) research publications are contributed by Shi, H. China and his publications are received 4492(29.22%) citations, CPP is 154.90, h-index is 24 and RCI value is 1.56. Followed by Wang, J. from the United States with 19(12.26%) research publications and it is received by 1719(11.18%) citations, CPP is 90.47, h-index is 16 and RCI value is 0.91. Third ranking author is Wu, C. from United Kingdom with 17(10.97%) research publications, 1738(11.31%) citations, CPP is 102.24, h-index is 13 and RCI value is 1.03.

Document Type Contributions in Micro plastic Pollution Research Publication

Table 8 Document Type Contributions in Micro plastic Pollution Research Publication

S.No	Document Type	Publications	%	Cumulative	%
1	Article	1336	79.57	1336	6.31
2	Review	236	14.06	1572	7.43
3	Conference Paper	30	1.79	1602	7.57
4	Book Chapter	25	1.49	1627	7.69
5	Note	20	1.19	1647	7.79
6	Editorial	12	0.71	1659	7.84
7	Letter	5	0.30	1664	7.87
8	Erratum	4	0.24	1668	7.88
9	Short Survey	4	0.24	1672	7.90
10	Conference Review	3	0.18	1675	7.92
11	Retracted	2	0.12	1677	7.93
12	Book	1	0.06	1678	7.93
13	Data Paper	1	0.06	1679	7.94
	Total	1679	100.00	21156	100.00

The document types are identified during the ten-year study period on micro plastic pollution in India research publications are shown in table- 8. From the study, it is identified that a maximum of 1336(79.57%) research publications are contributed by Article, followed by 236(14.06%) research publications are Review and third-placed in Conference Paper with 30(1.79%) research publications. This study confirmed that more than 95.41% of research publications are contributed by article, review, and conference paper. The remaining nearby 4.59% of research publications are identified in the other form documents. The lowest document type book, and data paper 1(0.06%).

Top 10 Institutions Contributions in Micro plastic Pollution Research Publication

Table 9 top Ten Institutions Contributions Micro plastic Pollution Research Publication

S.No	Institutions	Publications	%	Citations	%	CPP	H-Index	RCI
1	Chinese Academy of Sciences	114	21.71	6570	22.40	57.63	38	1.03
2	Ministry of Education China	97	18.48	2604	8.88	26.85	30	0.48
3	University of Chinese Academy of Sciences	66	12.57	4590	15.65	69.55	27	1.24
4	East China Normal University	54	10.29	5941	20.25	110.02	30	1.97
5	State Key Laboratory of Estuarine and Coastal Research	49	9.33	5428	18.51	110.78	28	1.98
6	CNRS Centre National de la Recherche Scientifique	36	6.86	909	3.10	25.25	15	0.45
7	Ministry of Land and Resources P.R.C.	33	6.29	695	2.37	21.06	16	0.38
8	Ministry of Agriculture of the People's Republic of China	27	5.14	769	2.62	28.48	13	0.51
9	Yantai Institute of Coastal Zone Research, Chinese Academy of Sciences	27	5.14	1181	4.03	43.74	13	0.78
10	University of Toronto	22	4.19	645	2.20	29.32	12	0.52
	Total	525	100.00	29332	100.00			

It is identified from the table 9, top 10 institutions are contributed a total number of 529 publications and it is received 29332 citations for the selected ten year study period in micro plastic pollution research output in India. From the study it is identified that, maximum

number of 114(21.71%) publications are contributed by Chinese Academy of Sciences, and it is received 6570(22.40%) citations, CPP is 57.63, h-index is 38 and RCI value is 1.03. Followed by Ministry of Education China contributed with 97(18.48%) research publications, 2604(8.88%) citations, CPP is 26.85, h-index is 30 and RCI value is 0.48. Third rank institution is University of Chinese Academy of Sciences with 66(12.57%) research publications, 4590(15.65%) citations, CPP is 69.55, h-index is 27 and RCI value is 1.24. The lowest University of Toronto with 22(4.19%) research publications, 645(2.20%) citations, CPP is 29.32, h-index is 12, and RCI is 0.52.

Top Ten Journals Contributions in Micro plastic Pollution Research Publication

Table 10 top ten Journals Contributions in Micro plastic Pollution Research Publication

S.No	Journals	Publications	%	Citations	%	CPP	H-Index	RCI
1	Science Of The Total Environment	276	25.99	12840	28.38	46.52	56	1.09
2	Marine Pollution Bulletin	259	24.39	8674	19.17	33.49	43	0.79
3	Environmental Pollution	204	19.21	12967	28.66	63.56	58	1.49
4	Journal Of Hazardous Materials	77	7.25	1814	4.01	23.56	25	0.55
5	Chemosphere	74	6.97	1648	3.64	22.27	23	0.52
6	Environmental Science And Technology	60	5.65	3281	7.25	54.68	29	1.28
7	Water Research	35	3.30	1522	3.36	43.49	20	1.02
8	Environmental Science And Pollution Research	32	3.01	1305	2.88	40.78	14	0.96
9	Ecotoxicology And Environmental Safety	25	2.35	624	1.38	24.96	10	0.59
10	Plos One	20	1.88	574	1.27	28.70	11	0.67
	Total	1062	100.00	45249	100.00			

Table 10 shows that, top10 journals contributions in the field of micro plastic pollution research publications in India. From the study it is identified that, a maximum of 276(25.99%) research

publications are contributed by Science Of The Total Environment and it is received by12840(28.38%) citations, CPP is 46.52, h-index is 56 and RCI value is 1.09. Followed by Marine Pollution Bulletin with 259(24.39%) research publications, 8674(19.17%) citations, CPP is 33.49, h-index is 43 and RCI value is 0.79. Third placed contributing Environmental Pollution with 204(19.21%) publications, 12967(28.66%) citations, CPP is 63.56, h-index is 58 and RCI value is 1.49. The lowest value of plos one with 20(1.88%) research publications, 574(1.27%) citations, CPP is 28.70, h-index is 11, and RCI is 0.67.

International Collaborated Countries in Micro plastic Pollution Research Publication

Table 11 International Collaborated Countries in Micro plastic Pollution Research Publication

S.No	Country	Publications	%	Citations	%	CPP	H-Index	RCI
1	China	545	37.15	21201	36.39	38.90	74	0.98
2	United States	192	13.09	8285	14.22	43.15	40	1.09
3	United Kingdom	145	9.88	7965	13.67	54.93	43	1.38
4	Germany	125	8.52	5763	9.89	46.10	36	1.16
5	Italy	108	7.36	2580	4.43	23.89	26	0.60
6	India	82	5.59	2169	3.72	26.45	24	0.67
7	Spain	76	5.18	1746	3.00	22.97	18	0.58
8	Australia	75	5.11	4178	7.17	55.71	34	1.40
9	France	62	4.23	1646	2.83	26.55	19	0.67
10	Canada	57	3.89	2727	4.68	47.84	22	1.20
	Total	1467	100.00	58260	100.00			
	Others Country- 88	945						

Table 11 shows that, top 10 international collaborated countries in micro plastic pollution research publications in India during the study period of 2012-2021. From this study it is identified that, a maximum of 545(37.15%) research publications are collaborated by China. Followed by United States with 192(13.09%) research publications, United Kingdom with 145(9.88%) research publications. The lowest country Canada with 57(3.89%) research publications, 2727(4.68%) citations, CPP is 47.84, h-index is 22, and RCI is 1.20. The highest citation is 21201(36.39%), CPP is 38.90, the h-index is 74, and RCI is 0.98. The lowest citations is 1646(2.83%), CPP is 26.55, the h-index is 19, and the RCI is 0.67. During the ten year study period total number of 1467 publications are collaborated by 88 countries 945 publications in other Countries.

Time Series Analysis in Micro plastic Pollution Research Publication

Table 12 Time Series Analysis in Micro plastic Pollution Research Publication

S.No	Years	Count(Y)	X	Y2	XY
1	2012	3	-5	25	-15
2	2013	3	-4	16	-12
3	2014	8	-3	9	-24
4	2015	16	-2	4	-32
5	2016	28	-1	1	-28
6	2017	38	1	1	38
7	2018	83	2	4	166
8	2019	151	3	9	453
9	2020	534	4	16	2136
10	2021	815	5	25	4075
	Total	1679		110	6757

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 **Jeyshankar and Ramesh babu (2013)**[21].

This study identified the future prediction of micro plastic pollution research publications in India for the year 2025 and 2030.

Straight Line Equation is

$Y = a + bx$

Here,

$\sum Y = 1679, \sum X^2 = 110, \sum XY = 6757$

$a = \sum Y/N = 1679/10 = 167.9 = 168$

$b = \sum XY/ \sum X^2 = 6757/110 = 61.4 = 61$

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

$Y = a + bx$

$= 168 + (110*10) = 168+1100 = 1435$

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

$Y = a + bx$

= 168 + (110*15) = 168 + 1650 = 1818

The estimated growth based on a time series analysis statistical application will be expected in the micro plastic pollution research publications in Indian in the year 2025 is around are equal to 1435 publications and the year 2030 is around are equal to 1818 publications. So that time serious analysis study conformed micro plastic research publications in India is increasing trend.

Top 10 Highly Cited Micro plastic Pollution Research Publication Publications

Table 13 top 10 Highly Cited Micro plastic Pollution Research Publication

S.No	Titles	Citations	Document type
1	Horton, A.A., et al (2017) Micro plastics in freshwater and terrestrial environments: Evaluating the current understanding to identify the knowledge gaps and future research priorities, Science of the Total Environment, 586, 127-141.	1040	Review
2	Eriksen, M., et al (2013) Micro plastic pollution in the surface waters of the Laurentian Great Lakes, Marine Pollution Bulletin77, 177-182.	868	Article
3	Auta, H.S., et al (2017) Distribution and importance of micro plastics in the marine environment A review of the sources, fate, effects, and potential solutions, Environment International, 102, 165-176.	846	Review
4	Van Cauwenberghe, et al (2013) Micro plastic pollution in deep-sea sediments	787	Article
5	Ivar Do Sul, J.A., and Costa, M.F. (2014) The present and future of micro plastic pollution in the marine environment, Environmental Pollution, 185, 352-364.	763	Review
6	Reid, A.J., et al (2019) Emerging threats and persistent conservation challenges for freshwater biodiversity, Biological Reviews, 94(3): 849-873.	702	Article
7	Free, C.M., et al (2014) High-levels of micro plastic pollution in a large, remote, mountain lake, Marine Pollution Bulletin, 85(1): 156-163.	650	Article
8	de Souza Machado, A.A., et al (2018) Micro plastics as an emerging threat to terrestrial ecosystems, Global Change Biology, 24(4): 1405-1416.	574	Note
9	Su, L., et al (2016) Micro plastics in Taihu Lake, China, Environmental Pollution, 216, 711-719.	499	Article

10	Mason, S.A., et al (2016) Micro plastic pollution is widely detected in US municipal wastewater treatment plant effluent, Environmental Pollution, 218,1045-1054.	444	Article

Table 15 indicates the high cited paper top 10 micro plastic research publications in India for the selected ten year study period. From the study it is identified that, a maximum number of 1040 citations are received by Horton, A.A., et al (2017) Micro plastics in freshwater and terrestrial environments: Evaluating the current understanding to identify the knowledge gaps and future research priorities, Science of the Total Environment, 586, 127-141. Followed by 868 citations from Eriksen, M., et al (2013) Micro plastic pollution in the surface waters of the Laurentian Great Lakes, Marine Pollution Bulletin 77, 177-182. Third rank by 846 citations from Auta, H.S., et al (2017) Distribution and importance of micro plastics in the marine environment A review of the sources, fate, effects, and potential solutions, Environment International, 102, 165-176. The top ten highly cited micro plastic research publications in India are contributed 06 articles and 03 review, and 01 note.

Major Finding

- The present study of scientometic analysis of micro plastic pollution research output in India. During the study period 2012 to 2021, the total number of 1679 research publications are contributed in micro plastic pollution in India. The maximum number of 815(48.54%) publications are contributed in the year 2021 and followed by 534(31.80%) publications in the year 2020, and 151(8.99%) publications in the year 2019. The average research publication per year is 167.9, the compound annual growth rate 75.15.
- During the maximum of 14804 (24.52%), citations are received 534 publications in the year 2020 Followed by 9255(15.33%) citations are received 83 publications in the year 2018. From the study, out of 1679 publications, 1537(100%) research publications are cited publications, and 148(100%) research publications are uncited publications
- From study the relative growth rate is 0.69 in the year 2013 and 0.66 in the year 2021. This study confirmed that, relative growth rate is decreasing trend from 2013 to 2020. At the same time, doubling time is found that 1.00 in the year 2012 and 1.04 in the year 2021. It is conformed that doubling time is increasing trend during the study period.
- The majority of the authors in the field are preferred to publish their research works in more than five authorship mode with 763(45.44%) publications. Followed by five authorship mode with 258(15.37%) publications, four authorship mode with 242(14.41%) publications
- During the degree of collaboration is between 0.97 in the year 2012 and 0.97 in the year 2021. The average degree of collaboration is 0.96. From this study it is identified that, majority of micro plastic research publications are contributed by collaborative authors.

- The study a maximum of CC value is 0.79 in the year 2013, and minimum of CC value is 0.47 in the year 2012. The average CC value is 0.69, the maximum of CI value is 4.76 in the year 2018 and a minimum of CI value is 2.67 in the year 2012.The average CI value 4.25. The maximum of MCC value is 4.82, and a minimum of MCC value is 4.00. The average MCC value is 4.75
- From the study that, CAI for single and two authorship contributions are decreasing trend from 1st block year to 2nd block year. At the same time CAI is increasing trend for three authors and more than three authors from 1st block year to 2nd block years (84.80) to (100.54).
- During the study authors that, the maximum of 29(18.71%) research publications are contributed by Shi, H. China and his publications are received 4492(29.22%) citations, CPP is 154.90, h-index is 24 and RCI value is 1.56. Followed by Wang, J. from the United States with 19(12.26%) research publications and it is received by 1719(11.18%) citations, CPP is 90.47, h-index is 16 and RCI value is 0.91.
- The study document type that, a maximum of 1336(79.57%) research publications are contributed by Article, followed by 236(14.06%) research publications are Review and third-placed in Conference Paper with 30(1.79%) research publications.
- From the study institutions that, the maximum number of 114(21.71%) publications are contributed by Chinese Academy of Sciences, and it is received 6570(22.40%) citations, CPP is 57.63, h-index is 38 and RCI value is 1.03. Followed by Ministry of Education China contributed with 97(18.48%) research publications, 2604(8.88%) citations, CPP is 26.85, h-index is 30 and RCI value is 0.48.
- During the study journals that, a maximum of 276(25.99%) research publications are contributed by Science Of The Total Environment and it is received by12840(28.38%) citations, CPP is 46.52, h-index is 56 and RCI value is 1.09. Followed by Marine Pollution Bulletin with 259(24.39%) research publications, 8674(19.17%) citations, CPP is 33.49, h-index is 43 and RCI value is 0.79.
- The study collaborative country that, a maximum of 545(37.15%) research publications are collaborated by China. Followed by United States with 192(13.09%) research publications, United Kingdom with 145(9.88%) research publications.
- The estimated growth based on a time series analysis statistical application will be expected in the micro plastic research publications in Indian in the year 2025 is around are equal to 1435 publications and the year 2030 is around are equal to 1818 publications are increasing trend.
- The highest cited paper of a maximum number of 1040 citations are received by Horton, A.A., et al (2017) Micro plastics in freshwater and terrestrial environments: Evaluating the current understanding to identify the knowledge gaps and future research priorities, Science of the Total Environment, 586, 127-141.

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