ZEBRAFISH RESEARCH IN INDIA- A BIBLIOMETRIC ANALYSIS

Kokilamani A. L.[1]*, Sreedhar H. K.[1], Sindhura Y.M.[1], Usma Khanum[1], Mythra N.[1], and Shashidhara M.[1]

[1]Department of Studies and Research in Zoology, Tumkur University, Tumkur, India

DOI: https://doi.org/10.56293/IJASR.2025.6403

IJASR 2025
VOLUME 8
ISSUE 2 MARCH - APRIL **ISSN: 2581-7876**

Abstract: Zebrafish (*Danio rerio*) is a prominent model organism in biological research in recent times. To know the current trend of research topics, scientists, Universities/institutions, funding organizations in the Zebrafish research has become our priority to take up this study. The study included the collection of articles on Zebrafish research published between 2000 to 2024 (July) particularly from Indian Authors through online databases-PubMed, Scispace, Web of Science, further transformed the collected bibliometric data into quantitative data and analysed it by using software tool RStudio-Biblioshiny-Bibliomatrix. From the study it has revealed that a total of 1,807 documents published from 2000 to 2024 in 672 journals, books etc., at 24.81% of annual growth rate with 18.57 average citations per document involving 8,109 authors from various institutions/University across the nation. In India UGC, and DBT are the leading funding agencies for zebra fish research. Our study provides a comprehensive and current trend on Zebra fish research in India and is baseline information to young researchers to conduct their experiments in new trend areas of zebrafish science and further Universities/institutions and funding agencies make informed decisions.

Keywords: Zebrafish, Bibliometric analysis, model organism, Zebrafish research in India

INTRODUCTION

Model organisms are non-human species that are used in research to help us understand specific areas of biology. Zebrafish (*D. rerio*) is one of the prominent model organisms in biological research. It is preferred by scientists because it exhibits similar kind of organ systems, physiological processes and diseases, including neurological disorders, cardiovascular diseases, cancer, and metabolic conditions to those of humans. Apart from this the rapid development of embryo outside the mother is particularly noteworthy; this fast development cycle allows researchers to quickly assess the effects of genetic modifications and environmental interventions (Michel Bourin, 2023). The contributions of zebrafish to our understanding of biology and disease are expected to expand even further due to continuous evolution of techniques and technologies. To understand and organize earlier findings on zebrafish science, the research scholars use different qualitative and quantitative literature reviewing approaches. The bibliometrics is one such, which has the potential to introduce a systematic, transparent, and reproducible review process based on the statistical measurement of science, scientists, or scientific activity. Unlike other techniques, bibliometrics provides more objective and reliable analyses. The overwhelming volume of new information, conceptual developments, and data are the milieu where bibliometrics becomes useful by providing a structured analysis to a large body of information, to infer trends over time, themes researched, identify shifts in the boundaries of the disciplines, to detect the most prolific scholars and institutions, and to present the "big picture" of extant research (Naveen Donthu *et al.*, 2021). Nicholas Silvestre *et al.*, (2020), and Ediane M G *et al.*, (2016) have documented the bibliometric features on zebrafish research from Brazialian Science and a global outlook on zebrafish research was analysed by Priyamvada Kinth, *et al.*, (2013); Salmi Ab. Aziz1, Mohd H. Mohd Nasir *et.al.*, (2021) and Michan.*et.al.*, (2010). But the collective perspective of scientific research on *Danio rerio* particularly from India is yet to be recorded. To know the current trend of research topics, scientists, Universities/institutions, funding organizations in the zebrafish research from Indian subcontinent has become our priority to take up this study.

MATERIAL AND METHODS

Methodology: The Bibliometric Analysis has been conducted for zebrafish (*D. rerio*) research work between the year 2000-2024 (July). The **s**tudy was conducted by collecting the research articles (Scientific Documents) published by Scientists, Academicians, Researchers from various Universities, Institutions and Colleges of India in National, International and Peer reviewed journals from Online Based Indexing Databases like Web of Science (WoS), PubMed, Google Scholar, Academia.edu.

The present study is based on publications and citations as indexed by Web of Science (WoS) for the period of 24 years from 2000 to 2024. The WoS published by Thomson Reuters, USA, is the on-line version of Science Citation Index (SCI)-Expanded of Institute for Scientific Information, Philadelphia, USA. The WoS includes more than 12,000 journals from 256 categories and more than 1,600 regional journals. It also covers open access journals and over 148,000 proceedings from the most significant conferences, symposia, seminars, colloquia, workshops and conventions worldwide (Pathak and Bharathi, 2014). The WoS was the primary source of data because it provides addresses of all the authors and includes selected journals (top 10–12% from every discipline). Data collection was done by using the keyword 'Zebrafish (*D. rerio*) Research in India'. The results obtained were further restricted to publication years 2000-2024.

Quantitative Analysis: All Records were retrieved for each Database and were systematized in a Database, then the Data sets were validated and normalized and a Quantitative Analysis for each category was done (Michan *et al.*, 2010 and Priyamvada Kinth *et al.*, 2013).

The data were downloaded in excel file for further analysis. The data collected from all the databases were then manually checked to avoid redundancy and anomalies and non-relevant records were removed. The data were compiled, analyzed and interpreted to know the growth of research publications, productive authors, status of national and international collaboration, focus on the interdisciplinary study and the preference of journals on the taxonomic research. By using software tool R-studio-Bibliometrix-Biblioshiny the collected qualitative data was converted into quantitative data and analysed for further study.

RESULTS

The Table 1 provides a comprehensive analysis of zebrafish research from 2000 to 2024 from India. It examines the growth in publication, key contributors, and collaborative efforts, offering insights into the evolution of this research domain.

1. Overview of data analysed:

Table 1: Overview of 2000-2024 results on *Danio rerio*

Timespan	2000:2024
Sources (Journals, Books, etc.)	**672**
Documents	**1807**
Annual Growth Rate %	24.81
Document Average Age	4.74
Average citations per doc	18.57
AUTHORS	
Authors	**8109**
Authors of single-authored docs	**20**
AUTHORS COLLABORATION	
Single-authored docs	**20**

Co-Authors per Doc	7.31
International co-authorships %	39.79
DOCUMENT TYPES	
Article	**1558**
article; early access	36
article; proceedings paper	**10**
article; publication with expression of concern	1
article; retracted publication	4
Correction	9
correction; early access	1
editorial material	8
Letter	2
meeting abstract	32
Retraction	1
Review	**137**
review; book chapter	**3**
review; early access	5

2. Annual Scientific Production in terms of number of articles published

The Table 2 shows the number of articles published each year from 2000 to 2024. The trend shows significant growth, with publications rising from just 1 in 2000 to 255 in 2023, and 204 in 2024 till July. The data in the file highlights a significant increase in the number of articles published from 2000 to 2024, with a total of 1,807 articles. The period began with very few publications, totalling only 12 articles between 2000 and 2004. However, from 2009 onwards, there was a steady rise in the number of articles, reaching 64 by 2015. The most dramatic growth occurred between 2016 and 2024 (Till July), with a peak of 255 articles in 2023. This trend represents an annual growth rate of 24.81%, reflecting a rapidly increasing academic interest in the subject, particularly in recent years.

Table 2: Year wise number of articles on *Danio rerio* published from India during 2000-2024

Year	Articles	Year	Articles
2000	1	2013	50
2001	3	2014	64
2002	2	2015	64
2003	3	2016	100
2004	3	2017	118
2005	6	2018	127
2006	5	2019	127
2007	6	2020	144
2008	**3**	2021	203
2009	11	**2022**	**222**
2010	27	**2023**	**255**
2011	28	2024	204
2012	31		

3. Most relevant journals

The top 10 most journals preferred by scientists to publish their research work on zebra fish were listed in the Table 3. Of the top 10 journals, "Scientific Reports" leads with the highest number of publications i.e., 49 articles, indicating its significant role as a platform for zebrafish-related studies. This is followed by "Zebrafish" journal with 34 articles, "Science of the Total Environment" with 32 articles, and "International Journal of Biological Macromolecules" with 31 articles. These journals collectively demonstrate a strong focus on environmental and biological macromolecular research. This variation in article counts reflects the diverse interest and research output in zebrafish studies across different scientific disciplines.

Table 3: The most relevant journals that published research articles on Zebrafish during 2000-2024 from India

Sources	Articles
Scientific Reports	49
Zebrafish	34
Science of The Total Environment	32
International Journal of Biological Macromolecules	31
Comparative Biochemistry and Physiology C-Toxicology \& Pharmacology	30
Environmental Toxicology and Pharmacology	24
Aquatic Toxicology	19
PloS One	19
Environmental Science and Pollution Research	18
Microbial Pathogenesis	18

4. Most productive Authors

Among the total number of contributors of 8109, the top 10 authors with minimum of 24 articles have considered as the most productive contributors in publishing the research articles on Zebrafish (Table 4). "Articles Fractionalized," represents the fractional contribution of each author, which accounts for their share of credit in co-authored papers. For example, if a paper has multiple authors, the total credit for that paper is divided among them, reflecting each author's contribution

Notably, ArockiaRaj J. of SRM Institute of Science & Technology, Chennai, has the highest number of articles with 78 publications, and his fractional contribution of 10.46 indicating his significant collaboration with others. Guru A. affiliated to Indian Institute of Science Education & Research (IISER) - Kolkata had 56 articles with 7.11 of fractional contribution. On the other hand, Bhat A has 26 articles but a higher fractional contribution of 9.60, suggesting a more substantial role in the publications of articles with his co-authors. This fractional approach allows for a more nuanced understanding of each author's impact, balancing both the quantity of work produced and the quality or significance of their contributions within collaborative efforts. The table 4 provides a comprehensive view of the academic productivity and influence of each author.

Table 4: Most productive Authors published number of articles from 2000 –2024 on Zebra fish

Authors	Affiliation Institute/University	Articles	Articles Fractionalized
Arockiaraj J.	SRM Institute of Science & Technology Chennai	78	10.45686258
Guru A.	SRM Institute of Science & Technology Chennai	56	7.111108336
Sivasubbu S.	CSIR - Institute of Genomics & Integrative Biology (IGIB)	42	5.774376436
Kumar A.	Council of Scientific & Industrial Research (CSIR) - India	38	6.222865039

Arokiyaraj S.	SRM Institute of Science & Technology Chennai	27	3.191702742
Bhat A.	Indian Institute of Science Education & Research (IISER) - Kolkata	26	9.604700855
Kulkarni P.	Acharya Nagarjuna University	26	3.263214286
Sudhakaran G.	SRM Institute of Science & Technology Chennai	25	2.761627262
Almutairi B. O.	SRM Institute of Science & Technology Chennai	24	2.721800422
Kumar K.	Dav College Chandigarh	24	2.723241525

5. Most productive Affiliation Institutions/ Universities

In the dataset provided, the scientific articles published by top 10 with minimum of 73 articles by various institutions. SRM Institute of Science and Technology, Chennai leads with the highest number of articles, totalling 175. Following closely are King Saud University of Saudi Arabia with 151 articles and Tata Institute Fundamental Research institute in Mumbai, Maharashtra with 88 articles (Table 5).

Table 5: The most productive Affiliation Institutions/ Universities

Affiliation Institutions/ Universities	Articles
SRM Institute of Science & Technology, Chennai	175
King Saud University, Riyadh, Saudi Arabia	151
Tata Institute Fundamental Research Institute in Mumbai, Maharashtra	88
Bharathiar University Tamil Nadu	86
Saveetha Dent College and Hospital Dental School in Chennai, Tamil Nadu	80
Anna University Public University in Chennai, Tamil Nadu	76
Sathyabama Institute of Science and Technology Private University in Chennai, Tamil Nadu	76
Academy of Scientific and Innovative Research Institute in Chennai, Tamil Nadu	75
College of Science and Humanities	75
Kalinga Institute of Industrial Technology University	73

King Saud University of Saudi Arabia is noted to be one of the foreign countries most collaborated with Indian Institutions/ Universities.

6. Corresponding Author's Country and Articles

The data reveals significant differences in research output across various countries, with India emerging as the predominant contributor. India has published 1,458 articles, constituting 80.69% of the total articles in the dataset. This substantial volume includes 1,073 Single Country Publications (SCP) and 385 Multi-Country Publications (MCP), which make up 26.41% of India's total publications. This indicates a robust research environment on Zebrafish in India, with a significant portion of its research being conducted in collaboration with international partners belong to 40 countries (Table 6).

Indian contributors were co-authored for most of the articles published by corresponding authors of USA (69) , China and Korea with 41, Germany, Japan, Sweden and UK with 19, 16, 14, and 13 respectively. This indicating India has a strong international collaboration in their research efforts. In contrast, countries such as Chile, Estonia, Iceland, Ireland, Israel, Mexico, Pakistan, Slovenia, Spain, Tanzania, Tunisia, and Zambia each have only one publication, representing a mere 0.06% of the total articles. These countries show no involvement in Multi-Country Publications (MCP), suggesting minimal engagement or presence in the specific research domain covered by the data.

The data suggests that while leading countries like India, the USA, and China dominate in terms of volume and international collaboration, many other countries have minimal representation. This reflects a concentration of research activity in a few key hubs, with substantial contributions from developed nations and limited involvement from many others. The high proportion of Multi-Country Publications in developed countries further emphasizes the trend towards global collaboration in research (Table 6 & Figure 1).

Table 6: Corresponding Author's Country and Articles (SCP, MCP)

Country	Articles	Articles %	SCP	MCP	MCP %
India	1458	80.6862203	1073	385	26.4060357
USA	**69**	**3.81848367**	**0**	**69**	**100**
China	41	2.26895407	0	41	100
Korea	41	2.26895407	0	41	100
Germany	19	1.05146652	0	19	100
Japan	16	0.88544549	0	16	100
Sweden	14	0.7747648	0	14	100
United Kingdom	13	0.71942446	0	13	100
Malaysia	11	0.60874377	0	11	100
Brazil	10	0.55340343	0	10	100
Saudi Arabia	10	0.55340343	0	10	100
Canada	9	0.49806309	0	9	100
Australia	7	0.3873824	0	7	100
Singapore	7	0.3873824	0	7	100
Norway	6	0.33204206	0	6	100

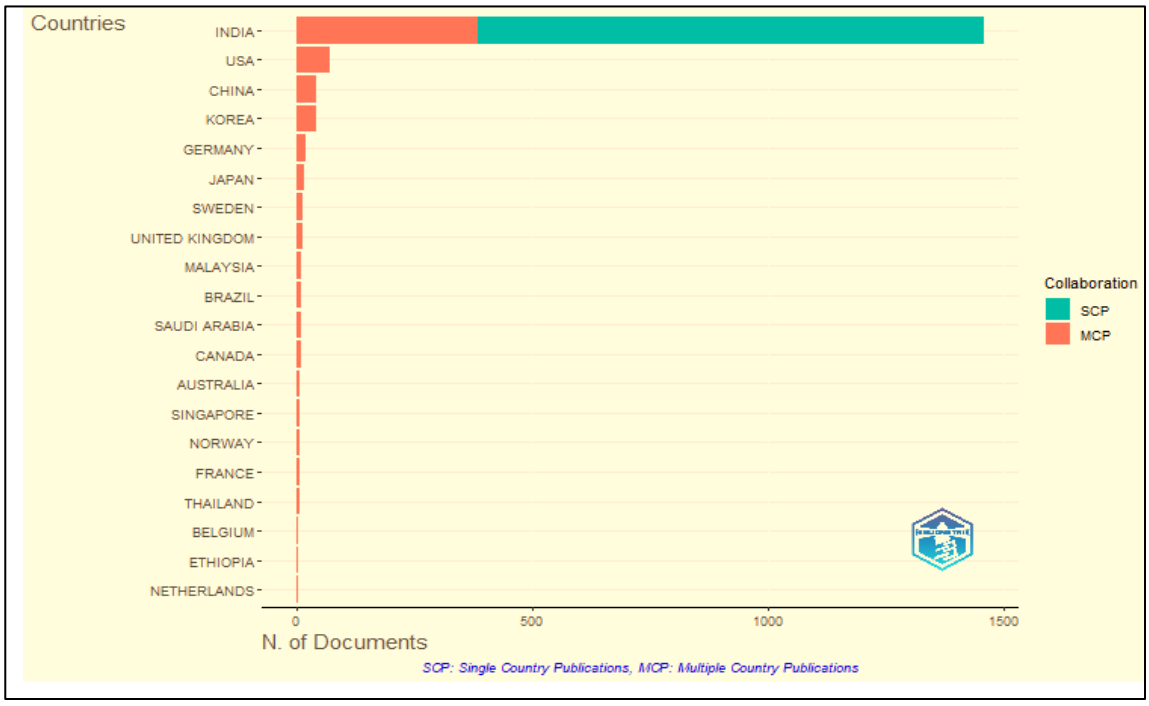

Figure 1: Graphical representation of Corresponding Author's Country and Articles (SCP, MCP)

8. India's collaboration with other countries

The research frequency data reveals a significant disparity in global research output. Indian contributors of various affiliated institutions/University have an impressive collaboration of maximum time i.e., 5,671 times when compared with other country's authors. Apart from these, Indian authors have collaborated with 70 countries

across the world, among these the authors from USA, South Korea, and Saudi Arabia were the top collaborators (Table 8). This high number underscores India's robust research environment and substantial output. In stark contrast several countries, including Colombia, Ecuador, Iraq, Kenya, Laos, Lithuania, Morocco, Serbia, Slovakia, Sudan, Tajikistan, and Uzbekistan, each have only one time collaboration with Indian authors. This minimal output indicates very limited engagement or activity in the research field covered by the dataset. Overall, the data highlights a concentration of research activity in a few leading countries, with India being the most prominent.

Table 8: India's Collaboration with other Countries

Country	Collaboration	Country	Collaboration
India	5671	Russia	33
USA	668	Pakistan	31
South Korea	289	Poland	31
Saudi Arabia	270	Belgium	29
China	235	Norway	28
Germany	223	Thailand	26
UK	158	Finland	24
Japan	131	South Africa	23
Canada	122	Chile	20
Brazil	115	Bangladesh	19
Sweden	109	Ethiopia	18
Malaysia	105	Switzerland	18
France	93	Czech Republic	17
Singapore	81	Denmark	15
Italy	72	Portugal	14
Australia	68	Israel	13
Egypt	46	Austria	11
Iran	43	Oman	11
Netherlands	41	Mexico	10
Spain	34	Tanzania	9

9. Total citation and Maximum citable authors

A total of 1565 articles were cited from 2000 to 2024, among these the top documents that have cited for the maximum time with a minimum of 114 citations (Table 9). Ahamed M. has the highest total citations with 980. Despite having a moderate TC per year of 65.33, its high total citation count indicates long-term significance and continued relevance in its field.

Table 9: DOI Number and Total Citation and Maximum Citable Authors and Published Year

Paper	DOI	Total Citations	TC per Year	Normalized TC
Ahamed M, 2010, Clinical Chimica Acta	10.1016/j.cca.2010.08.016	980	65.3333333	15.4105999
Akerboom J, 2012, Journal of Neuroscience	10.1523/JNEUROSCI.2601-12.2012	893	68.6923077	14.0880407
Anbumani S, 2018, Environmental Science and Pollution Research	10.1007/s11356-018-1999-x	465	66.4285714	15.3949426
Agnihotri S, 2013, Nanoscale	10.1039/c3nr00024a	412	34.3333333	9.52821462
Jalali S, 2013, PLoS One	10.1371/journal.pone.0053823	361	30.0833333	8.34875116

Rauta PR, 2012, Immunology Letters	10.1016/j.imlet.2012.08.003	320	24.6153846	5.04834606
Rajagopal A, 2008, Nature	10.1038/nature06934	246	14.4705882	2.5625
Chakraborty C, 2016, Journal of Nanobiotechnology	10.1186/s12951-016-0217-6	217	24.1111111	6.62797801
Tuschl K, 2016, Nature Communications	10.1038/ncomms11601	204	22.6666667	6.2309102
Joglekar MV, 2009, Gene Expression Patterns	10.1016/j.gep.2008.10.001	200	12.5	2.68620269
Chakraborty C, 2009, Current Drug Metabolism	10.2174/138920009787522197	195	12.1875	2.61904762
Shestopalov IA, 2007, Nature Chemical Biology	10.1038/nchembio.2007.30	182	10.1111111	3.87234043
Bera K, 2014, Analytical Chemistry	10.1021/ac404160v	174	15.8181818	5.45347698
Yao K, 2018, Nature	10.1038/s41586-018-0425-3	168	24	5.5620438
Mokalled MH, 2016, Science	10.1126/science.aaf2679	164	18.2222222	5.0091631
Karthik C, 2017, Journal of Hazardous Materials	10.1016/j.jhazmat.2017.03.037	163	20.375	7.22810973
Pal T, 2018, ACS Omega	10.1021/acsomega.7b01323	157	22.4285714	5.19786236
Jagmag S A, 2016, Frontiers in Neuroscience	10.3389/fnins.2015.00503	141	15.6666667	4.30665852
Clark K J, 2011, Nature Methods	10.1038/NMETH.1606	138	9.85714286	5.4041958
Maharajan K, 2018, Aquatic Toxicology	10.1016/j.aquatox.2018.01.010	133	19	4.40328467
Osman AI, 2023, Environmental Chemistry Letters	10.1007/s10311-023-01593-3	131	65.5	27.0924574
Sarkar S, 2014, Ecotoxicology and Environmental Safety	10.1016/j.ecoenv.2014.05.012	130	11.8181818	4.07443683
Saleem S, 2018, Cell Death Discovery	10.1038/s41420-018-	128	18.2857	4.237747

10. Nature of Work

Nature of work indicates the study of specific subject. The nature of work in zebrafish research involves several specific activities and focuses due to the unique characteristics of this organism. Zebrafish is used in various studies like Environmental Science and ecology, Genetics, Cell Biology, Developmental Biology, Biochemistry & Molecular Biology, Life Science and Biomedicine & other topics, etc. Zebrafish researchers have conducted experiments on nearly 147 various disciplines of science, among them the following areas have a greater number of research (Table 10).

Table 10: Nature of Work

Nature of work	Total number
Environmental Sciences & Ecology	75
Science & Technology - Other Topics	36
Environmental Sciences & Ecology; Pharmacology & Pharmacy; Toxicology	24
Chemistry	20
Developmental Biology; Zoology	19
Environmental Sciences & Ecology; Toxicology	19
Biochemistry & Molecular Biology	18

Pharmacology & Pharmacy	15
Biochemistry & Molecular Biology; Endocrinology & Metabolism	13
Life Sciences & Biomedicine - Other Topics	10

11. Funding Organizations in India

Among 672 research publications on Zebra fish of which 535 have funded by 20 Funding Organizations across India from 2000-2024. It has observed that "University Grant Commission", New Delhi under Govt. of India has funded for 129 researchers in conducting their research on zebrafish. This is the Highest Funding Organizer in India. "Department of Biotechnology (DBT), Govt. of India" funded for 82 researchers in India from 2000-2024. This is the second Funding Organiser in India. Piramal Life Sciences Limited, Mumbai a private body, was the minimum funding Organisation. These implies that these organizations have encouraging the scientific community to conduct research in India (Table 11).

Table 11: Funding Organizations in India for Zebrafish Research

Sl. No	Funding organizations	Total No.
1	**UGC- University Grants Commission, New Delhi, India**	**129**
2	Department of Biotechnology (DBT), Govt. of India	82
3	Indian Council of Medical Research(ICMR),Govt. of India, New Delhi	63
4	Indian Council of Agricultural Research (ICAR), Ministry of Agriculture, India	35
5	Science and Engineering Research Board (SERB), New Delhi, India	30
6	DRDO, Ministry of Defence, Govt. of India	28
7	Central Institute of Fisheries Education of Mumbai, India	28
8	Council of Scientific and Industrial research (CSIR) , India	28
9	Indian Institute of Science Education and Research Kolkata (IISER), India	27
10	Department of Science and Technology,(DST),Govt of India	27
11	Centre for Biotechnology, SOA (Deemed to be University)	11
12	Indian Institute of Science Kolkata (India)	10
13	National Science Foundation [IOS-1257562]; Division of Environmental Biology; Direct for Biological Sciences [1257562] Funding Source: National Science Foundation	6
14	Department of Life Sciences, Manipur University	4
15	All India Council for Technical Education (AICTE), New Delhi; ICMR, New Delhi	3
16	Paraiyar University [PU/AA-3/URF/2015]	3
17	Indian Council of Medical Research, Govt of India	3
18	Sathyabama Institute of Science and Technology (Deemed to be University), Chennai, India	2
19	Bharathiar University, Coimbatore, Tamil Nadu [C2/13151/2016]	1
20	Piramal Life Sciences Limited, Mumbai	1

DISCUSSION

The *Danio rerio* (Zebra fish) is an emerging model system in several research areas. In this context, the present study revised the historical use and trends of zebra fish as experimental model in India. The articles produced from Indian authors on zebrafish research were 50 in the earlier years of 2000-2005, it might be due to less usage of zebrafish as model organism by Indian scientists or publications of articles in low indexed journals. But there was an exponential production of zebrafish research articles from 28 articles in 2011 to 255 in 2023. It implies the more usage of zebrafish as model organism and articles published in high indexed journals by Indian scientists. The concurrent

observations were noticed in Brazalian Science too (Ediane Mario Gheno *et al.*,2016 and Nicholas Silvestre S T *et al.*, 2020).

A total of 8109 contributors involved in zebrafish research, among them 20 authors are single author and there is a high percentage of 39.79 co-authorship with international/national collaborators. It implies that the research network among Indian and international scientists has contributed a lot more in zebra fish science. Further, our present study revealed that the experiments on zebrafish has been increased in India and is evidenced by exponential growth in the publications of articles. It might be due to increase in the number of collaborations with the fellow researchers of India or foreign countries. According to Priyamvada *et al.* (2013) observations, India has ranked 21st position in the world top 25 most productive countries with 50 institutions engaged in zebrafish research. It is further substantiated from our observations that the topmost productive institutions/universities have encouraging their researchers to use zebrafish as model organism. The scientists prefer a good database indexed journals to publish their quality research. A multidisciplinary journal like Scientific Report has been preferred as one of the top 10 most productive journals by zebrafish researchers as well as other scientific researchers. The 2nd most productive journal-Zebrafish as an exclusive journal for publications of zebrafish research become one of the most preferred journals during 2000 to 2024. Journals like Zebrafish, PLoS One, Aquatic Toxicology are preferred by scientists from all over the globe as these journals are globally visible and all database indexed journals. Our results are matching with previous works of Ediane M. G. *et al.*, (2016) and Priyamvadu *et al.*, (2013).

The citation impact is a measurement of scientific publications usability. It also emphasize paying homage to pioneers, giving credit to related work, identifying methodology, offering background reading, validating data, substantiating claims, analyzing previous work, informing researchers of forthcoming work, rectifying ones' own work, rectifying the work of others, identifying the original publications in which an idea or concept is discussed, identifying original publications that describe concepts or eponym terms, disputing work or idea of others, and disputing the primacy of others' claims (Ediane M G *et al.*, 2016). Based on the present WoS database analysis it is observed that the year 2008 noted to be the maximum number of research articles cited year for 3 research articles on Zebrafish with 96 mean TC per article and 5.65 Mean TC per year. The Year 2009 the second highest cited year for 11 articles with 74.45 MeanTC /article and 4.65 MeanTC/year. This is further substantiated the upward trend in zebrafish research from Indian contributors.

The most global cited document, a review article "Silver Nanoparticle applications and human health" by Ahamed *et al.*, exemplified the experiments through *Drosophila* and zebrafish as model organisms published in 2010, Clinica Chemica acta journal has 980 citations. This signifies the importance of model organisms like *Drosophila* and zebrafish in scientific research as alternate system to human body. A total of 28 documents on zebrafish are observed to be cited more than 100 times at the global level. Co-authorship action arises from affinities and common goals to be reached.

Collaboration levels can be recognized as "Intra" or "Inter." The first one includes national collaboration established among individuals of the same group, department, institution, sector, or nation. The second one includes international collaboration, with the same characteristics of national collaboration. Based on the present WoS database analysis Indian contributors of zebrafish research have maximum time collaboration with USA of 668 times. Being one of the developed countries of the world USA lies in the topmost scientific countries with respect to zebrafish research (Priyamvadu *et al.*, 2013; Ediane M. G. *et al.*, 2016; Nicholas Silvestre S T *et al.*, 2020). Further, our findings emphasized the contributors of zebra fish articles have collaborated 3334 times with Indian and international scientific community. Most of the times the zebrafish contributors have collaborated with the counterparts of institutions from Saudi Arabia, USA, Germany, and UK.

Financial aid for any kind of scientific research will boost up the enthusiasm in scientist community as well as the quality of the research, overall, which uphold the nations' scientific level at the global scenario. In India, the Central and State Governmental organizations (UGC, DST, DBT, DRDO, CSIR, SERB, IISER etc.) and few private organizations (Paraiyar University, Bharathiar University Coimbatore, Sathyabama Institute of Science and Technology, Chennai etc.) are supporting zebrafish scientist community in producing high quality of research. Based on our WoS database analysis UGC, DST, DBT are the leading funding organizations in India for Zebrafish research. This implies that the Indian Government is supporting their scientists at the global level and further this will impact on the economic growth of the nation.

From our bibliometric analysis it is noticed that the experiments have conducted on nearly 147 various disciplines of science and have used zebrafish as study material particularly Environmental Science and Ecology, Science and Technology, Chemistry, Pharmacology, Pharmacy and Toxicology, Biochemistry and molecular Biology are some of them. This implies that our researchers are emerging with new ideas according to the changes in the scenario at the global level. Our output is in congruent with the earlier findings of Priyamvadu *et al*., (2013).

CONCLUSION

Consideration of zebrafish has substantially increased in scientific research; the current report can serve as a basis for resetting public policies for the development of new scientific centres of zebrafish research and/or for investing in improvements on the existing ones. Further, the study provides a comprehensive and current trend on zebra fish research in India and enhances the enthusiasm in young researchers to conduct their research and publish their articles in well indexed and worldwide circulated journals. By analyzing publication data, bibliometric can provide insights into the dynamics of zebra fish research, helping researchers, Universities/Institutions and funding agencies to make informed decisions.

ACKNOWLEDGEMENT

All the contributors of this article are grateful to Prof. Rupesh, DOSR in Library and Information Science, Tumkur University, Tumakuru and Mr. Devanath P.R. Research Scholar DOSR in Library and Information Science, Tumkur University, Tumakuru for providing us the guidance in usage of Software Tool- R-studio-Bibliometrix-Biblioshiny during our study period.

REFERENCES

1. Bourin, M. (2023). Zebrafish, a model organism. *International Journal of Pharmacology and Toxicology*, 11(1),1-2. https://doi.org/10.14419/ijpt.v11
2. Donthu, N., Kumar, S., Mukherji, D., Pandey, Nitesh., & Weng Marc Lim., (2021). How to conduct a Bibliometric Analysis: An Overview and guidelines. *Journal of Business Research*, 133, 285-296. https://doi.org/10.1016/j.jbusres.2021.04.070
3. Gheno, E. M., Rosemberg, D. B., Souza, D. O., & Calabro, L. (2016). Zebra fish in Brazilian Science: Scientific
4. Production, Impact and Collaboration. *Zebra fish*, 3(3), 217-225. DOI:10.1089/zeb.2015.1183.
5. Kinth, P., Mahesh G. & Panwar, Y. (2013). Mapping of Zebrafish research: A Global Outlook. *Zebrafish*,10(4)5,510-514. DOI:10.1089/zeb.2012.0854.
6. Michán, L., Castañeda, S. A., Rodríguez-Arnaiz R., & Ayala F. J. (2010). Global *Drosophila* Research: A
7. Bibliometric Analysis. *Drosophila Information service*, 93,232-241.
8. Pathak, M. & Bharati, K. A., (2014). Botanical Survey of India (1971–2010). A Scientometric analysis. *Current Science*, 106(7), 964-971.
9. Salmi Ab. Aziz, Ab Rashid Jusoh, Mohd H. Mohad Nasir, Rahimah Zakaria, Zahiruddin Othman, Asma H. Ahmad, Aidi Ahmi., (2021).The 100 Most Cited Articles in Zebrafish: A Bibliometric Perspective. *Egyptian Journal of Aquatic Biology and Fisheries*, 25(2).935-946.ISSN 1110-6131.
10. Triguerio, N.S.S., Canedo, A., Braga, D. L. S., Luchiart, A. C. & Rocha, T. L. (2020). Zebrafish as an emerging Model System in the Global South: Two Decades of Research in Brazil. *Zebrafish*, 17(6):412-425. Doi:10.1089/zeb.2020.1930

