Mapping the evolution of Aquaculture Research: A Scientometric Analysis

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Abstract

The main objective of this study is to know the research trend in the field of aquaculture across the world. A total of 25,614 records has been retrieved from the Web of Science database for a period of 10 years i.e. from 2011 to 2020. The study examined the year-wise research output, various types of documents preferred by the researchers, and most productive journals in aquaculture literature. The analysis of the study revealed that there is an increasing trend in terms of research productivity during the period. A maximum number of 4,480 (17.49%) papers were published in the year 2020 and the lowest number of 1,511 (5.90%) papers were published in the year 2011. India has contributed 1,239 papers during the study period. The National Natural Science Foundation of China is the topmost funding agency by sponsoring for 2,602 publications

Keywords
Scientometric, Aquaculture, Web of Science, India

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1. Introduction

Scientometrics is the field of study which concerns itself with measuring and analyzing scholarly literature (Parvin et al., 2019). Scientometrics deals with the quantitative analysis of scientific documents. Major research issues include the measurement of the impact of research papers and academic journals, the understanding of scientific citations, and the use of such measurements in policy and management contexts. In practice there is a significant overlap between scientometrics and other scientific fields such as information systems, information science, science of science policy, sociology of science, and metascience. Critics have argued that over-reliance on scientometrics has created a system of perverse incentives, producing a publish or perish environment that leads to low quality research.

2. Review of Literature

Chandra and Jayabal (2018) have carried out a scientometric analysis of the Indian Journal of Medical Microbiology during the span of five years from 2013 to 2017. The study reveals that maximum numbers of articles were contributed by multiple authors. Gupta et al. (2018) have examined 1,744 Indian publications on rheumatoid arthritis research as indexed in Scopus database. Santos and Vianna (2018) study revealed that the number of articles on aquaculture of Paralichthys surpassed all other areas of study and focused on the species of greatest economic interest. Amin and Parekh (2019) has made an attempt to study the research output of biochemistry, genetics and molecular biology of Gujarat University, Ahmedabad from 1980 to 2018. A study done by Zhang, X., & Zhou, G. (2019) showed that the USA, China, and the Netherlands own overwhelming positions in the water impression field.Marisha and Singh (2019) in their examination found the certainties of the articles distributed in the diary 'Current Science'. A sum of 18897 records has been taken for investigation, which has recovered from the Web of Science database.Chithiraivel, Sivasekaran and Ramalinagam (2020) have presented the trends in EosinophiliaLiterature with a sample of 12,118 research articles downloaded from the Web of Science database during the period 1998 to 2017. de Castilhos Ghisi et al. (2020) have analyzed the publication patterns of main topics related to Glyphosate research.Surulinathi et al. (2021) have studied the Indian Contribution in Animal Behaviour Research and found that There were as many as 120 countries actively engaged research with Indian

researchers, which produced 10,030 publications during the study period.

3. Scope and limitations of the study

The present study is based on the research papers indexed in the Web of Science database during the period 2011 to 2020 i.e., for 10 years. The researchers tried to analyze the research publication that are published on aquaculture literature. The subject coverage is limited to aquaculture literature only. The data collection was done from Web of Science database which has a total of 25,614 records that are published during 2011-2020. The period 2011 to 2020 was taken into consideration for data collection.

4. Objectives of the study

The objective of the present study is to:

- To know the world and Indian research productivity on aquaculture.
- To identify the core research areas in aquaculture.
- To know the country-wise distribution of aquaculture publications.
- To classify the most productive author(s), institution, funding agencies in aquaculture research.
- To identify the major funding agencies on aquaculture.

5. Methodology

The data has been retrieved from the Web of Science scientific citation database maintained by Clarivate Analytics for ten years. The necessary data related to aquaculture publications from global for a period of ten years (2011-2020) are collected by using basic search field in Web of Science. In the address field of basic search option the word "Aquaculture" was used. Additionally, in the publication year field from 2011- 2020 was searched. With these efforts, a total 25,614 records were saved in text file format and also in Excel file format. The retrieved data were analyzed using Histcite software, VOS viewer software and Microsoft excel spread sheet.

6. Data Analysis and Interpretation

6.1. World Research Productivity on Aquaculture

A total of 25,614 records were published from 2011 to 2020. Out of 25,614 records, the highest numbers of records were published in the year 2020 with 4,480 (17.49%) records, followed by 3,839 (14.99%) in the year 2019. The lowest records were published in the year 2011 with 1,511 articles. The data shows that there is a growing trend during the study period. The cumulative output aquaculture is increasing every year from 2011 to 2020.

Table 1: World Research Productivity on Aquaculture

Sl. No.	Year	No. of Records	Percentage	Cumulative Records	Cumulative Percentage
1	2011	1511	5.90	1511	5.90
2	2012	1621	6.33	3132	12.23
3	2013	1727	6.74	4859	18.97
4	2014	1919	7.49	6778	26.46
5	2015	2135	8.34	8913	34.80
6	2016	2559	9.99	11472	44.79
7	2017	2767	10.80	14239	55.59
8	2018	3056	11.93	17295	67.52
9	2019	3839	14.99	21134	82.51
10	2020	4480	17.49	25614	100
	Total	**25614**	**100**		

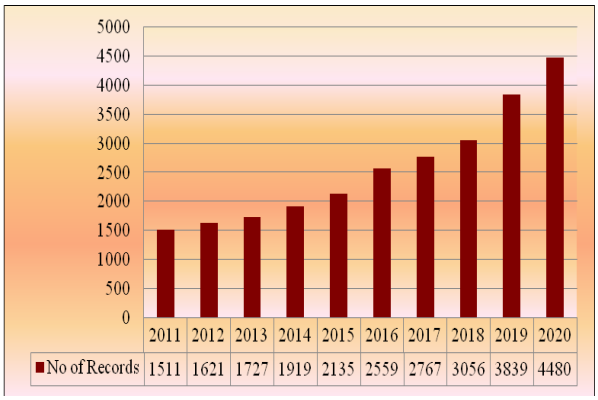

Figure 1: World Research Productivity on Aquaculture

6.2. Indian Research Output in Aquaculture

The data shows that from 2011 to 2020 India has published 1,239 research papers. The highest number of records i.e. 259 was published in the year 2020 followed by 184 articles in 2019 and it has decreased by 125 articles in 2018. The lowest number of records i.e. 65 records was published in the year 2011. There is an fluctuation in aquaculture research productivity during 2011 to 2020.

Table 2: Indian Research Output in Aquaculture

Bibliographic Forms	No. of Records	Perc-entage	Cum-ulative Records	Cumu-lative Percentage
Journal Articles	22669	88.50	22669	88.502
Review Articles	1807	7.05	24476	95.557
Proceedings Papers	464	1.81	24940	97.369
Editorial Materials	215	0.84	25155	98.208
Meeting Abstracts	211	0.82	25366	99.032
Book Chapters	45	0.18	25411	99.207
Early Access	44	0.17	25455	99.379
Corrections	43	0.17	25498	99.547
News Items	42	0.16	25540	99.711
Letters	27	0.11	25567	99.817
Book Reviews	19	0.07	25586	99.891
Data Papers	18	0.07	25604	99.961
Retracted Publications	6	0.02	25610	99.984
Retracted Publications	3	0.01	25613	99.996
Reprints	1	0.00	25614	100
Total	**25614**	**100**		

Table 3: Bibliographic Forms

Sl. No.	Year	Number of Records	Perc entage	Cumulative Records	Cumulative Percentage
1	2011	65	5.25	65	5.25
2	2012	68	5.49	133	10.73
3	2013	93	7.51	226	18.24
4	2014	94	7.59	320	25.83
5	2015	93	7.51	413	33.33
6	2016	120	9.69	533	43.02
7	2017	138	11.14	671	54.16
8	2018	125	10.09	796	64.25
9	2019	184	14.85	980	79.10
10	2020	259	20.90	1239	100.00
Total		**1239**	**100**		

6.3. Bibliographic Forms

The Indian aquaculture communicated their research results in variety of communication formats. The data shows that the main form of research outputs are journal articles, which contribute 22,669 (88.50%) and are considered as an important primary source of information. It is followed by review articles (7.05%) and proceedings papers (1.81%). These three types of documents together contribute 24,940 (97.36%) of the total research output. Remaining 2.64% records are scattered as editorial materials, meeting abstracts, book chapters, early access, corrections etc.

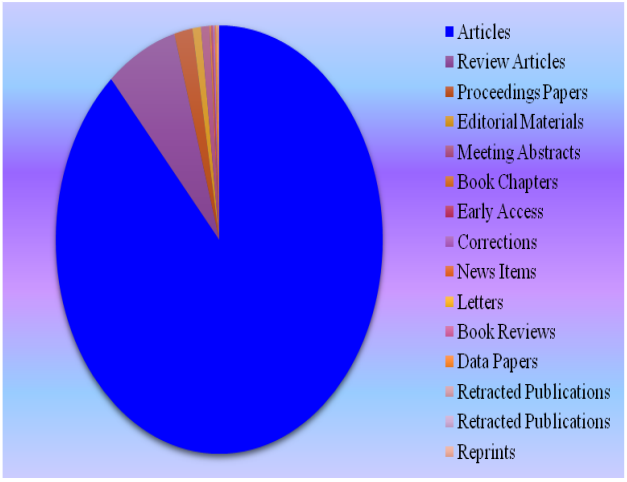

Figure 2: Bibliographic Forms

6.4. Core Research areas in Aquaculture

The core research areas in aquaculture has been identified and it has presented in table 4. It is observed that maximum number of publications are in the topic of fisheries and marine freshwater biology. Out of top 10 research areas Fisheries 10,048 (24.32%) contributed the highest number of records and the next position taken by Marine Freshwater Biology 7,669 (18.56%) followed by Environmental Sciences Ecology 4,413 publications (10.68%) Veterinary Sciences 2,309 (5.59%) publications Agriculture 1,693 (4.10%) publications.

Table 4: Core Research areas in aquaculture

Research Areas	No. of Records	Per centage	Cumu-lative records	Cumu-Lative Percentage
Fisheries	10048	24.32	10048	24.32
Marine Freshwater Biology	7669	18.56	17717	42.88
Environmental Sciences Ecology	4413	10.68	22130	53.56
Veterinary Sciences	2309	5.59	24439	59.14
Agriculture	1693	4.10	26132	63.24
Biotechnology Applied Microbiology	1580	3.82	27712	67.07
Science Technology Other Topics	1450	3.51	29162	70.57
Immunology	1220	2.95	30382	73.53
Oceanography	1143	2.77	31525	76.29
Biochemistry Molecula r Biology	1059	2.56	32584	78.86

6.5. Country wise Distribution of aquaculture publications

The country wise literature on aquaculture has been analyzed among top 10 countries based on number of publications.It is observed that the country Peoples Republic China tops with 5,214 (17.23%) publications. It is followed by USA with 3,729 (12.32%) publications Spain with 1,741 publications. China USA and Spain are the most productive countries by securing first second and third rank respectively. India is in 8th place by contributing 1,685 research papers in global aquaculture research.

Table 5: Country wise Distribution

Country	No. of Records	Perce ntage	Cumulative records	Cumulative Percentage
Peoples R China	5214	17.23	5214	17.23
USA	3729	12.32	8943	29.55
Spain	1741	5.75	10684	35.30
Norway	1685	5.57	12369	40.87
Australia	1582	5.23	13951	46.10
Brazil	1559	5.15	15510	51.25
Canada	1316	4.35	16826	55.60
India	1239	4.09	18065	59.69
France	1029	3.4	19094	63.09
Italy	977	3.23	20071	66.32

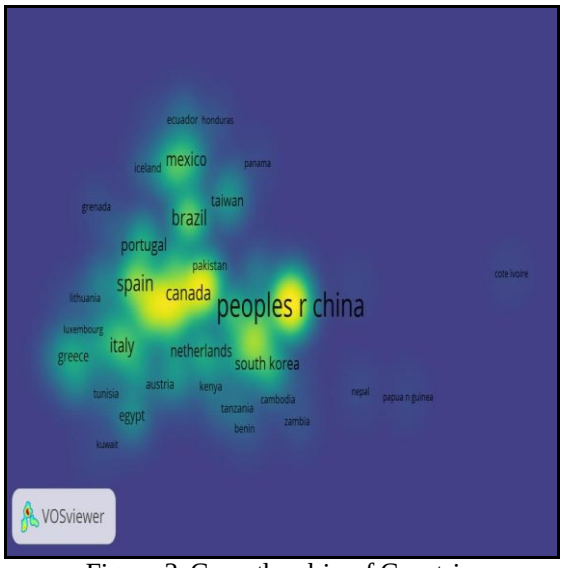

Figure 3: Co-authorship of Countries

6.6. Language-wise Distribution of Publications

The publications on aquaculture research are spread over 13 different languages. The most predominant language used for communication is English. The English language contributions are about 98.36% and the rest of 1.66% are scattered to other 12languages.

Table 6: Language-wise Distribution

Languages	No. of Records	Perce ntage	Cumulative records	Cumulative Percentage
English	25193	98.36	25193	98.36
Spanish	179	0.70	25372	99.06
Portuguese	99	0.39	25471	99.44
Japanese	65	0.25	25536	99.70
Chinese	26	0.10	25562	99.80
French	23	0.09	25585	99.89
German	9	0.04	25594	99.92
Polish	9	0.04	25603	99.96
Malay	4	0.02	25607	99.97
Dutch	2	0.01	25609	99.98
Italian	2	0.01	25611	99.99
Turkish	2	0.01	25613	100
Norwegian	1	0.00	25614	100
Total	**25614**	**100**		

6.7. Most Productive Authors in Aquaculture Research

According to study highest publications are contributed by Liu Y occupies first rank with 185 (0.72%) articles followed by Zhang Y is in second rank by contributing 125 (0.49%) papers Li J is in third rank by publishing 122 (0.48%) papers. Further Li Y with 114 publications Wang J with 98 publications Wang L with 96 publications Wang Y with 92 publications Li L with 89 publications Esteban MA with 77 publications have also found a significant place in the list.

Table 7: Most Productive Authors in Aquaculture Research

Author	No. of Records	Per centage	Cumulative records	Cumulative Percentage
Liu Y	185	0.72	185	0.72
Zhang Y	125	0.49	310	1.21
Li J	122	0.48	432	1.69
Li Y	114	0.45	546	2.13
Wang J	98	0.38	644	2.51
Wang L	96	0.37	740	2.89
Wang Y	92	0.36	832	3.25
Li L	89	0.35	921	3.60
Esteban MA	77	0.30	998	3.90
Xu P	77	0.30	1075	4.20

6.8. Top Ranked Institutions and Organizations

The study has identified most active institutions engaged in aquaculture research.According to the Web of Science database Chinese Academy of Sciences contributed the highest publication to the field of aquaculture i.e. 1,055 publications followed by Chinese Academy of Fishery Sciences published 791 publications Indian Council of Agricultural Research 517 publications Ocean University of China 490 publications University of Chinese Academy of Sciences 469 publications Centre National De La Recherche Scientifique 447 publications.

Table 8: Top Ranked Institutions and Organizations

Institutions/Organizations	No. of Records	Percentage	Cumulative Records	Cumulative Percentage
Chinese Academy of Sciences	1055	4.12	1055	4.12
Chinese Academy of Fishery Sciences	791	3.09	1846	7.21
Indian Council of Agricultural Research	517	2.02	2363	9.23
Ocean University of China	490	1.91	2853	11.14
University of Chinese Academy Of Sciences	469	1.83	3322	12.97
Centre National De La Recherche Scientifique	447	1.75	3769	14.71
Shanghai Ocean University	437	1.71	4206	16.42
Institute of Marine Research Norway	401	1.57	4607	17.99
Wageningen University Research	381	1.49	4988	19.47
IFREMER	375	1.46	5363	20.94

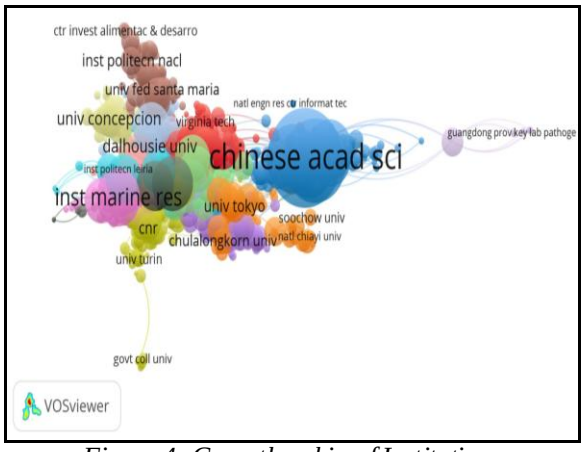

Figure 4: Co-authorship of Institutions

6.9. Funding Agencies

Various research institutions/organizations/funding agencies are a sponsor for research projects in aquaculture. It is found from the table that the National Natural Science Foundation of China has in 1st rank by sponsoring for 2,602 research papers followed by the European Commission securing 2nd rank by sponsoring for 1,454 research papers Conselho Nacional De Desenvolvimento Cientifico E Tecnologico sponsored for 741 research papers Research Council of Norway sponsored for 568 research papers.

Table 9: Funding Agencies in Aquaculture Research

Funding Agency	No. of Records	Percentage	Cumulative Records	Cumulative Percentage
National Natural Science Foundation of China Nsfc	2602	22.47	2602	22.47
European Commission	1454	12.55	4056	35.02
Conselho Nacional De Desenvolvimento Cientifico E Tecnologico Cnpq	741	6.40	4797	41.42
Research Council of Norway	568	4.90	5365	46.32
Coordenacao De Aperfeicoamento De Pessoal De Nivel Superior Capes	506	4.37	5871	50.69
Portuguese Foundation for Science and Technology	407	3.51	6278	54.20
Natural Sciences and Engineering Research Council of Canada Nserc	367	3.17	6645	57.37
Consejo Nacional De Ciencia Y TecnologiaConacyt	357	3.08	7002	60.46
Uk Research Innovation Ukri	347	3.00	7349	63.45
Ministry Of Education Culture Sports Science And Technology Japan Mext	345	2.98	7694	66.43

6.10. Most productive journals in Aquaculture

Most productive journals according to their productivity has been arranged in the decreasing order based on productivity. The journal "Aquaculture" hold the first rank and the journal published 2,531 (9.88%) research papers. The second rank holds by "Aquaculture Research" the journal published 1,112 (4.34%) research papers. The "Fish Shellfish Immunology" holds the 3rd rank; the journal published 867 (3.38%) research papers. The "Aquaculture International" holds the 4th rank; the journal published 511 (2%) research papers. The "Plos One" holds the 5th rank; the journal published 467 (1.82%) research papers.

Table 10: Most productive journals in Aquaculture

Journal Name	No. of Records	Percentage	Cumulative Records	Cumulative Percentage
Aquaculture	2531	9.88	2531	9.88

Aquaculture Research	1112	4.34	3643	14.22
Fish Shellfish Immunology	867	3.38	4510	17.61
Aquaculture International	511	2.00	5021	19.60
Plos One	467	1.82	5488	21.43
Aquacultural Engineering	370	1.44	5858	22.87
Reviews in Aquaculture	367	1.43	6225	24.30
Journal of Fish Diseases	310	1.21	6535	25.51
Aquaculture Environment Interactions	296	1.16	6831	26.67
Journal of the World Aquaculture Society	293	1.14	7124	27.81

6.11. Keyword Analysis

The keyword analysis has been done by using Histcite and VOS Viewer software. Table 11 displays the analysis of keywords used in aquaculture research output. The Table lists the first top 10 keywords that have got coverage in 1,000+ records. The most often used keyword is 'Aquaculture which occurred in 5,078 records. This is followed by the term 'Fish which occurred in 2,840 publications. The publications used the key terms such as 'Growth (8.27%) 'Effects' (6.85%) 'Sea' (5.98%) and 'Water' (5.20%) and so on.

Table 11: Keyword Analysis on Aquaculture Research

Sl. No.	Word	Records	Percentage
1	Aquaculture	5078	19.83
2	Fish	2840	11.09
3	Growth	2119	8.27
4	Effects	1754	6.85
5	Sea	1531	5.98
6	Water	1331	5.20
7	Analysis	1227	4.79
8	Marine	1205	4.70
9	Shrimp	1203	4.70
10	Using	1190	4.65

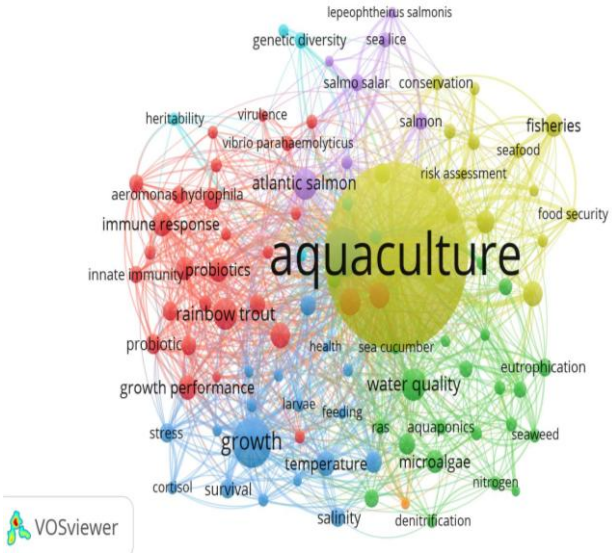

Figure 5: Co-occurrence of Keywords

7. Major Findings

8.

The major findings of the study are;

- The world aquaculture contribution i.e., 25,614 for 10 years. A maximum number of 4,480 (17.49%) papers are published in the year 2020 and a minimum number of 1,511 (5.90%) papers are published in the year 2011. The number of papers in aquaculture research is in growing trend during the study period.
- India has contributed a total of 1,239 papers during the study period. The highest number of publications i.e. 259 published in the year 2020 and the lowest number of publications i.e. 65 was published in the year 2011.
- Bibliographic forms of publications reveal that most of the publications are from journals (88.50%), followed by review articles (7.05%) and proceedings papers (1.81%).

- The study revealed the fact that the main thrust areas of research are in fisheries with 10,048 (24.32%) publications, followed by marine freshwater biology with 7669 (8.81%) publications.
- The Peoples R China with 5214 (17.23%) publications occupies first place followed by the USA with 3,729 (12.32%), Spain with 1,741 (5.75%), Norway with 1,685 (5.57%), and Australia with 1,582 (5.23%) research publications respectively. India occupies the 8th position in the world in terms of publication.
- Language-wise distribution of publications reveals that English is the most preferred language with 98.36% of publications. The study shows that only 1.64% of publications are contributed by languages other than English.
- The ranked list of highly productive authors shows that Liu Y is the most productive author contributing 185 papers, followed by Zhang Y with 125 papers and Li J with 122 papers.
- Chinese Academy of Sciences contributed the highest number of papers in aquaculture research with 1,055 (4.12%) publications, followed by the Chinese Academy of Fishery Sciences with a share of 791 (3.09%) publications.
- The National Natural Science Foundation of China is the topmost funding agency by sponsoring for 2,602 publications, followed by European Commission is in the second rank by sponsoring for 1,454 publications.
- The most often used keyword is 'Aquaculture' which occurred in 5,078 records, followed by the term 'Fish' which occurred in 2,840 publications, 'Growth' occurred in 2,119 publications, effects occurred in 1,754 publications.
- The study indicates that the journal Aquaculture tops the list with the highest number of publications (2,531), followed by Aquaculture Research with a share of 1,112 papers and Fish Shellfish Immunology with 867 papers.

9. Suggestions

The following impact measures to improve the aquaculture research based on the findings of the present study:

- Scientists need toput more efforts on the neglected areas by being hopeful to carry out more research activities.
- Required to motivate and inspire researchers and scientists in this field of aquaculture to carry out research to recognize the impact of research output.
- The funding agencies, universities, and other research institutions/organizations are to be provided with more financial assistance in the form of research grants and complicated equipment to enhance the quality of research as they lay behind the exclusive research institutes.

10. Conclusion

The study gives interesting and important findings concerning the various information sources used by the aquaculture research scholar. The study is significant since such a study incorporating all facts of scientometric analysis of research publications in the subject of aquaculture in the world has never been conducted so far. Scientometric dimensions of aquaculture research help the research scholars to understand and use the information and the sources used. It gives a clear picture to the library managers to organize and disseminate the resources. The thrust areas of research in aquaculture and other salient features of research publications were identified. Scientometric studies are relevant for researchers, policy, and decision on makers and researchers outside the library and information science field to trace the current trends of research in the specific field.

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