



Research Article

Analysis Bibliometrically of Publications on Grass Carp (*Ctenopharyngodon idella*) Research Between 2013 and 2023

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Abstract | Grass carp (*Ctenopharyngodon idella*) species are among the commercially most valuable. To find patterns and trends in the published research on this subject, we used a bibliometric approach to evaluate the body of literature that has been published in the field of grass carp study over the last ten years (2013–2023). Based on articles retrieved from Scopus, the analysis was carried out; a total of 1751 research publications were examined. The bibliometric analysis's findings showed that China led the world in both total research output and the contributions of its researchers. The same is true for educational establishments. Therefore, collaboration between institutions and on an international scale both tended to make the research more impactful. Future priorities should include international collaboration, stimulation and improvement.

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Introduction

Because they offer both technical staff and state-of-the-art scientific information, universities, and public research institutes are widely acknowledged as essential sources of innovation (Whittington *et al.*, 2009). Star scientists and technical personnel can be found, in particular, at universities (Kenney, 1988; Murray, 2002). Moreover, the knowledge and technologies that universities and public research institutions have examined are more accessible than those from other organizations, even though they generally operate on the principles of

open science (Smith and Powell, 2004). The last 20 to 30 years have seen a notable growth in the total amount of research produced worldwide, especially in the fields of aquaculture and fisheries science (Natale *et al.*, 2012; National Science Board, 2014). Fisheries technologies are developing to support food sustainability by ensuring a steady supply of fish and fishery products. According to Fujii *et al.* (2017), there are regional variations in the availability of fish resources, consumer preferences for fisheries products, and environmental concerns that influence the priorities for research and development (R&D) in fishery technology.

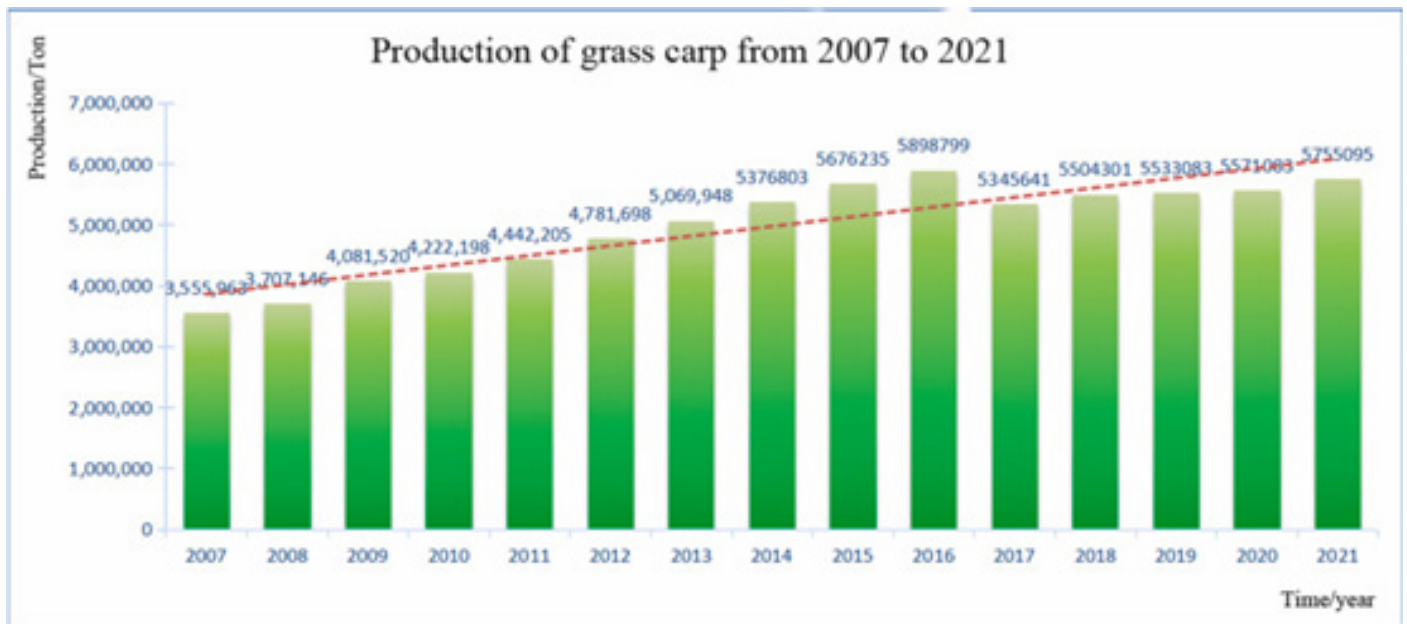


Figure 1: Grass carp production map from 2007 to 2021.

Consequently, a variety of factors have driven this, such as the increasing importance and pervasiveness of aquaculture across an ever-expanding range of species, and the need for enhanced science to direct fisheries management, particularly when taking the ecosystem approach (Natale *et al.*, 2012; FAO, 2012).

In 2018, grass carp accounted for 10.5% of the world's total freshwater fish production, making it the most popular species farmed worldwide, according to FAO (2020). The next most popular species were common carp, *Cyprinus carpio* (7.7%), Nile tilapia, *Oreochromis niloticus* (8.3%), and silver carp, *Hypophthalmichthys molitrix* (8.8%) (Taher, 2022). This species was China's most significant freshwater aquaculture in 2022, whose yield of 5.76 million tons in 2021 accounted for 18.08% of the country's overall production in this sector (FAMA, 2022). The aquaculture output of grass carp has been increasing annually in recent years due to the rise of market demand; it went from 355,5963 tons in 2007 to 575,5095 tons in 2021, with a growth rate of 61.84%. This has contributed positively to the supply of protein (Wang *et al.*, 2024) (Figure. 1).

According to the Fisheries Bureau of Ministry of Agriculture, in 2023, grass carp production in China alone reached 5.9 million tons in 2022, which represents one-fifth of the total freshwater aquaculture production (Ji *et al.*, 2024).

The natural habitats of grass carp are northwest China and southeast Russia. Several nations have purposefully introduced this herbivorous animal in order to

control vegetation. Furthermore, Bozkurt *et al.* (2017) reported that grass carp are an important source of protein for human consumption and an integral part of fish husbandry. This species is also used in management to control problematic aquatic vegetation (Morris and Clayton, 2006; Dick *et al.*, 2016; Bozkurt *et al.*, 2017). But non-native grass carp populations are considered invasive in areas such as the USA and Europe, where their ability to displace aquatic vegetation and multiply can have wide-ranging negative ecological effects (Pipalova, 2006; Jones *et al.*, 2017; Wildhaber *et al.*, 2023). As of 2022, grass carp are the only invasive carp species in North America known to be reproducing in the Great Lakes Basin, specifically in tributaries to western Lake Erie (LeRoy *et al.*, 2024). In general, grass carp is a herbivorous fish with a wide global range and increasing ecological significance. It is also a fish of economic importance, but in their natural habitat, grass carp are essentially herbivorous, consuming certain aquatic plants (Wu *et al.*, 2012, Ni and Wang, 1999). Its daily ration (the ratio of the total weight of feed consumed in a day to the weight of the fish) can reach 49.9% when it eats aquatic plants (Sifa *et al.*, 2014). Additionally, Wu *et al.* (2012) evaluated the impact of grass carp on aquatic organisms and water quality by combining the findings of earlier ecological studies. The integration of bibliographical data indicates that aquatic plant preference is probably connected to the amount of cellulose, calcium, sucrose, and citric acid in the aquatic plant. However, under suitable conditions, adult grass carp can consume more than its weight of plant material daily (Bozkurt *et al.*, 2017; Li *et al.*, 2023).

Genetically, natural grass carp have 48 chromosomes, making them diploid. Triploid grass carp (3N) with an extra pair of chromosomes were created in the 1980s by studying this species. Therefore, the process of producing triploid grass carp is the same as that of diploid fish, except that fish containing an extra pair of 72 chromosomes are formed from fertilized eggs that have been exposed to heat, cold, or pressure shock. These fish are sterile due to extra chromosomes (Sutton *et al.*, 2012)

During recent decades, a considerable amount of information has been published on grass carp (Dibble and Kovalenko, 2009). The literature has dealt with grass carp on two sides, one as a species for breeding and one as a source of protein, that is, from the aspect of food security, while the other aspect is that this species is an invasive fish and has impacts on the environment. Therefore, Dibble and Kovalenko (2009) conducted a literature analysis to ascertain whether earlier research has examined ecological impacts and the underlying processes of such impacts. The analysis uncovered over a thousand papers, but it lacked information on ecological interactions and how they affect habitat complexity and community-structuring mechanisms, of the citations he located on the effects of grass carp, fewer than half mentioned “ecology,” and none of them offered evidence for a causal theory. However, because most research has focused on the biology of introduced grass carp and the efficacy of aquatic plant eradication, the authors concluded that current knowledge was insufficient to accurately predict the long-term effects of grass carp on freshwater ecosystems (Jones *et al.*, 2017).

Wittmann *et al.* (2014) recently used meta-analysis to review and assess the experimental data currently available regarding the ecological effects of grass carp. The authors looked at both the direct and indirect ecological effects of grass carp, including both biotic effects on macrophytes, invertebrates, fish, amphibians, and birds as well as abiotic effects on dissolved oxygen, turbidity, nutrients, and pH. They did this by conducting a fixed-effects model meta-analysis. In the same vein, Jones *et al.* (2017) found that 18 of the 193 research studies examined the effects of grass carp.

Numerous assessments have been published in the fields of grass carp research. However, no attempts have been made to provide a more quantitative as-

essment of this research's present status and potential developments in the future. Neff and Corley (2009) suggest that bibliometric analysis is an effective technique that makes it possible to evaluate research goals across disciplines. Numerous assessments have been published in the fields of grass carp research. However, no attempts have been made to provide a more quantitative assessment of this research's present status and potential developments in the future. Neff and Corley (2009) suggest that bibliometric analysis is an effective technique that makes it possible to evaluate research goals across disciplines. therefore, the present review - in our opinion- will offer researchers a reliable source of information that could help them comprehend the current areas of focus for aquaculture research as well as other major scientific metrics.

Materials and Methods

Curation of data

The Scopus database is used to start the curating of data. When compared to other databases, the Scopus database was selected because of its excellent coverage and scientific quality (Mongeon *et al.*, 2016; Pham-Duc *et al.*, 2020). Initially, a keyword-focused search strategy is used to look up cited publications between 2013 and 2023 using the terms “grass carp” AND “Ctenopharyngodon idella” in the literature.

There were 2,485 articles found overall from the search. The topic of debate (Agricultural and Biological Sciences, Environmental Sciences, Biochemistry, Genetics and Molecular Biology, Immunology and Microbiology, and Veterinary) was decided upon in the following step, which also involved determining the time span from 2013 to 2023. In the third step, Document type (Article, Review, Conference paper and book chapter) was selected, and in the fourth step, Keyword (Ctenopharyngodon idella, grass carp and Ctenopharyngodon) was selected. Source type (Journal, book and conference proceeding) is selected. The last step is to select the English language only. The final number of articles was only 1,751.

Analysis of data

Every publication's author list, number of authors, affiliations, publishing subject category (based on ISI journal categorization), journal names, and citations were examined. Gauffriau *et al.* (2007) reported that the “whole counting method” was used as a broad counting technique. The total number of publications

Table 1: *The top ten highly productive journals on grass carp in period (2013–2023).*

Journal	TP	TC	Cite Score (2023)	The Most Cited Article (Reference)	Times Cited	Times Cited
Fish And Shellfish Immunology	2847	25537	9.0	Polyethylene microplastics trigger cell apoptosis and inflammation via inducing oxidative stress and activation of the NLRP3 inflammasome in carp gills	36	Elsevier
Aquaculture	4674	37137	7.9	Biofloc: A sustainable dietary supplement, nutritional value and functional properties	31	Elsevier
Developmental and Comparative Immunology	958	5505	5.7	Effects of two host-associated probiotics <i>Bacillus mojavensis</i> B191 and <i>Bacillus subtilis</i> MRS11 on growth performance, intestinal morphology, expression of immune-related genes and disease resistance of Nile tilapia (<i>Oreochromis niloticus</i>) against <i>Streptococcus iniae</i>	9	Elsevier
Journal of Fisheries of China	774	901	1.2	Fisheries stock enhancement assessment: progress and prospect	5	Shanghai Ocean University
Fish Physiology and Biochemistry	603	3232	5.4	Recent progress in practical applications of a potential carotenoid astaxanthin in aquaculture industry: a review	5	Springer Nature
Aquaculture Research	2119	7398	3.5	Meta-Analysis of the Causality of Deformations in Marine Fish Larvae Culture	0	Hindawi
Aquaculture Nutrition	654	4142	6.3	Microalgae as Raw Materials for Aquafeeds: Growth Kinetics and Improvement Strategies of Polyunsaturated Fatty Acids Production	7	Wiley-Blackwell
Environmental Science and Pollution Research	17818	141408	7.9	Alternative energy and natural resources in determining environmental sustainability: a look at the role of government final consumption expenditures in France	127	Springer Nature
Frontiers in Immunology	19982	188368	9.4	The development of COVID-19 treatment	40	Frontiers Media SA
Acta Hydrobiologica Sinica	692	688	1.0	Selenium-rich cardamine <i>hupingshanensis</i> on growth, biochemical indices, selenium metabolism, antioxidant capacities and innate immunities in juvenile black carp (<i>mylopharyngodon piceus</i>)	4	Institute of Hydrobiology, Chinese Academy of Sciences

(TP), the most cited article (Reference), the number of citations, and the publisher for each of the top ten journals on the subject of grass carp were examined. On the other hand, the list of 10 authors, their quantity, their association, and the publication's subject category. [Gaufriau et al. \(2007\)](#) stated that the “comprehensive counting method” was used as a generic counting technique.

In general publication citations (TC) were considered since the amount of time that has passed since an article was published has a significant impact on its overall citation count. This process is consistent with the instant effect assessment method proposed by [Qiu and Chen \(2009\)](#). The definition of the num-

ber of citations per publication based on TC was the total number of citations over the entire number of publications (i.e., standardized as a citation ratio per publication; [Hsieh et al. 2004](#)). Hirsch's (2004) h-index was also employed to assess the influence of publishing. This indicator, which replaces the widely used commercial impact factor, is being pushed as a practical means of assessing journal performance, it shows the number of papers (h-index) per capita when combined with the number of citations ([Hirsch 2010](#); [Braun et al. 2006](#)). On the other hand, the fourteen advanced countries in the field of grass carp research and the most productive academic Institution were analysed.

Table 2: List of the ten most prolific authors in the grass carp.

Author	Year of 1 st Publication	TP	h-Index	TC	Current Affiliation	Country
Feng, Lin	2008	304	59	10,771	Animal Nutrition Institute, Sichuan Agricultural University	China
Liu, Yang	2008	325	59	10,875	Animal Nutrition Institute, Sichuan Agricultural University	China
Tang, Ling	2009	212	49	7,578	Fish Nutrition and Safety Production University Key Laboratory of Sichuan Province	China
Jiang, Weidan	2009	288	56	10083	Animal Nutrition Institute, Sichuan Agricultural University	China
Zhou, Xiaoqiu	2006	313	61	11192	Animal Nutrition Institute, Sichuan Agricultural University	China
Wu, Pei	2011	213	48	7147	Animal Nutrition Institute, Sichuan Agricultural University	China
Kuang, Shengyao	2009	211	49	7541	Animal Nutrition Institute, Sichuan Academy of Animal Science	China
Jiang, Jun	2008	217	56	9605	College of Animal Science and Technology, Sichuan Agricultural University	China
Zhang, Yongan	1999	147	49	8011	Hubei Hongshan Laboratory, College of Fisheries, Huazhong Agricultural University	China
Tang, Wuneng	2015	76	38	3497	Animal Nutrition Institute, Sichuan Academy of Animal Science	China
Feng, Lin	2008	304	59	10,771	Animal Nutrition Institute, Sichuan Agricultural University	China

Technically, each selected publication's title, abstract, and keywords were fully downloaded in a comma-separated values (.csv) file format. The association strength approach of VOS Viewer's co-occurrence mapping (network, overlay, and density visualization) was then used to these data, and as a significant supplemental factor, the publishing time from 2019 to 2022 was also included. A software tool called VOS viewer version 1.6.14 is used to analyze large volumes of data from bibliometric networks, make maps based on data networks found in literatures, and investigate and visualize graphical analysis (density, overlay, and network visualization) on these maps (Colle *et al.*, 1978; Bettoli *et al.*, 1993; Jones *et al.*, 2017). A co-occurrence map was used to depict the network semantically, taking into account the confirmed picked keywords from many papers. For the bibliometric analysis, every term in the search string that was displayed in the previously described sections was considered an important unit of analysis. Nevertheless, in view of this, a few small adjustments were made.

Bibliometric analysis

Bibliometric analysis provides a concise viewpoint in contrast to traditional reviewing methods, which makes it a suitable review system to highlight the general state and direction of research (Costa *et al.*, 2017; Qaiser *et al.*, 2017). The analysis of research goals across an entire discipline is one area that other

forms of inquiry neglect, and it is made possible by the powerful tool that is bibliometric analysis.

The scientific community and policy makers may find interest in this information as it may offer insight into changes in research goals and scientific tendencies (Neff and Corley, 2009). On the other hand, this method, which Pritchard presented in 1969, uses statistics to assess published literature in order to gauge how inspired or adopted a research idea is by scholars. This technique's capacity to record the temporal evolution of several parameters adds to its distinctiveness (Zhu *et al.*, 2019). The research on Agri-Food Waste as a Sustainable Alternative in Aquaculture (Bertocchi and Mannino, 2022; Prabakusuma *et al.*, 2023), Trends in Fisheries Science (Jarić *et al.*, 2012; Aksnes *et al.*, 2016), Mapping the research on Aquaculture (Natale *et al.*, 2012), Food Security (Xie *et al.*, 2021), Fisheries hydroacoustic assessment (Liu *et al.*, 2023), and so forth demonstrate the validity of using bibliometric studies as literature analysis tools.

Results and Discussion

In the present results, shown in Table 1, the analysis criteria for the content analysis of the most cited journals were "Total Publication," "Total Citation," "Cite Score of the journal," "The most cited article," "Times cited," and "Publisher." According to Table

2, “Fish and shellfish immunology” was the most productive journal in terms of articles on grass carp, with a total of 2847 publications and 25537 citations. “Aquaculture” followed with 4674 publications and 37137 citations, as well as “Developmental and comparative immunology” with 958 publications and 5505 citations.

Table 3: List of the 14 most productive articles countries in the grass carp.

Country	TP	Most Productive Academic Institution
China	1191	State Key Laboratory of Freshwater Ecology and Biotechnology, Institute of Hydrobiology, Chinese Academy of Sciences,
USA	120	State Key Laboratory of Food Science and Technology, School of Food Science and Technology, Jiangnan University, Jiangsu Province
Pakistan	47	Department of Computer Science, University of Gujrat
India	39	Department of Biology, Hong Kong Baptist University
Brazil	32	Department of Ecology and Vertebrate Zoology, Faculty of Biology and Environmental Protection, University of Łódź, Łódź
Iran	23	Department of Animal Sciences, Lorestan University
Egypt	21	Key Laboratory of Freshwater Animal Breeding, Ministry of Agriculture of China
Canada	19	Department of Ecology and Vertebrate Zoology, Faculty of Biology and Environmental Protection, University of Łódź, Łódź
Germany	14	Animal Nutrition Institute, Sichuan Agricultural University, Chengdu
UK	12	State Key Laboratory of Freshwater Ecology and Biotechnology, Institute of Hydrobiology, Chinese Academy of Sciences
Iraq	8	Tegnervägen 6B, Katrineholm
Ireland	7	College of Light Industry and Food Sciences, South China University of Technology
Japan	7	Department of Ecology and Vertebrate Zoology, Faculty of Biology and Environmental Protection, University of Łódź, Łódź
Australia	6	Department of Food Science, Ningbo University, Ningbo

On the flip side, research was also conducted on the most prolific writers in the grass carp. As indicated in Table 3, the following criteria were selected for the content analysis of the prolific writers in the field of online learning readiness research: “Author,” “Total Publications,” “h-index,” “Total citations,” “current affiliation,” and “country.” The most authored writers in the field of grass carp are displayed in Table 3. All ten authors are from China, according to the bibliometric analysis. The most productive author was “Liu, Yang,” who had 325 articles overall, the highest h-index of 59, and 10875 citations. “Feng, Lin” comes next with 304 articles overall, an h-index of 59, and 10771 citations.

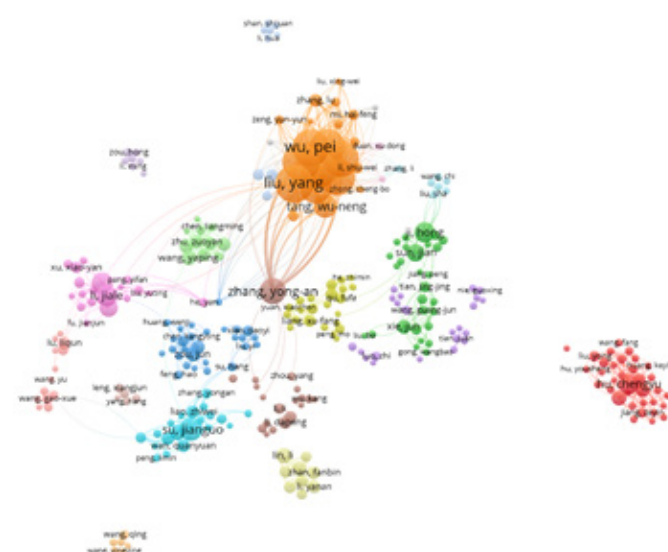


Figure 2: Analysis of productive writers in grass carp.

Table 4: List of the ten most productive countries grass carp.

Rank	Country	TP	Most Productive Academic Institution
1	China	447	Ministry of Education of the People's Republic of China
2	China	446	Chinese Academy of Sciences
3	China	412	Ministry of Agriculture of the People's Republic of China
4	China	379	Institute of Hydrobiology, Chinese Academy of Sciences
5	China	340	Huazhong Agricultural University
6	China	305	Shanghai Ocean University
7	China	259	Chinese Academy of Fishery Sciences
8	China	216	Sichuan Agricultural University
9	China	207	University of Chinese Academy of Sciences
10	China	168	Northwest A&F University

As indicated in Table 4, and Figure 3, the analysis criteria for the most productive countries in the on-line learning ready research domain were “country,” “Total Publications,” and “most productive academic institution.” It is noted that the country that produces the most research is China (1191), and this value is considered the highest compared to the rest of the country combined, followed by the USA (190), while the rest of the countries were low in the number of articles (Figure 4). In any case, the productivity of Arab countries notes that Egypt ranked seventh with 21 research papers, while Iraq ranked eleventh with only nine research papers.

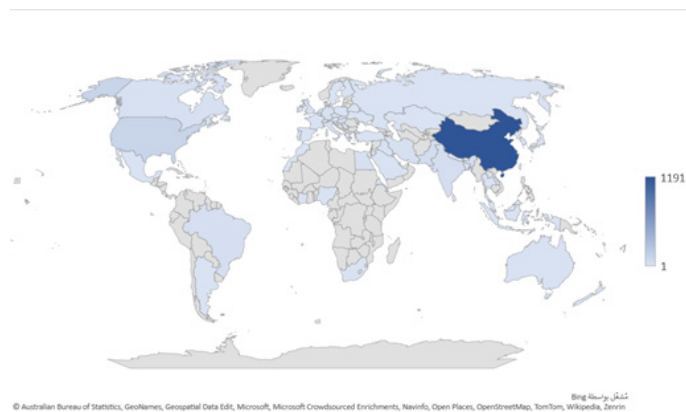


Figure 3: A world map showing the country's most productive for common carp research.

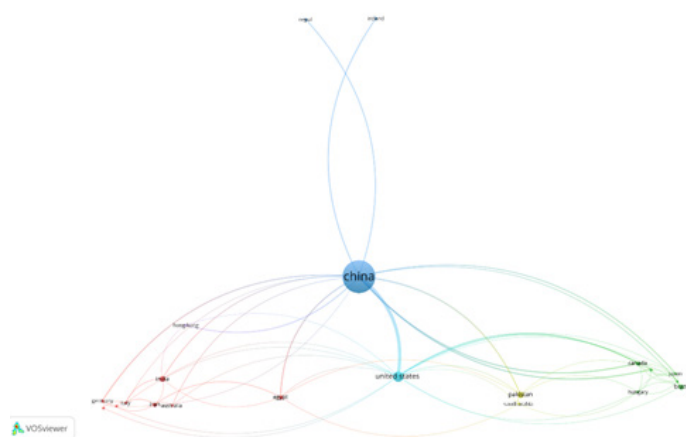


Figure 4: Analysis results of productive countries in grass carp.

Based on Table 4, it can be inferred that China leads the world in grass carp research productivity (Figure 5). The ministry of education of the people's republic of China, the Chinese academy of sciences, and the ministry of agriculture of the people's republic of China appear to be the most advanced Chinese academic institutions, with a total of 447, 446, and 412 articles, respectively, while Northwest A&F University had the lowest number, with 168 articles.

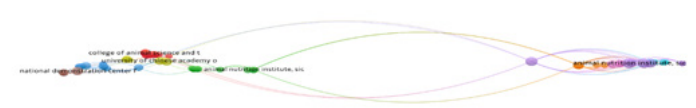


Figure 5: Results of an inter-academic analysis of grass carp research.

In the world of scholarly publishing, recognition and visibility are critical. Scholars and researchers hope that their work will be disseminated, acknowledged, and mentioned by colleagues and peers. Gaining this distinction requires, among other things, that your journal be indexed in esteemed databases. Of these, Scopus is a well-known indexing database that has a big influence on the legitimacy and readership of scholarly publications. Because of its reliability, Scopus is used as a source of bibliometric data for extensive analysis in research evaluations, research landscape studies, assessments of science policies, and university rankings. The unrestricted availability of Scopus data for particular studies by the academic research community, such as through application programming interfaces, has led to several papers using Scopus data to study themes including researcher mobility, network visualizations, and geographical bibliometrics (Kunti, 2023; Baas et al., 2020).

A journal can be accessed by a large number of scholars and researchers who are actively looking for high-quality research publications when it is indexed in Scopus. Therefore, the focus of study inside Scopus was on eminent scientists worldwide who were writing in reputable publications (such Fish and Shellfish Immunology, Aquaculture, Developmental and Comparative Immunology, Aquaculture study). Since Scopus is a curated database, information is selected for inclusion in the database following a rigorous procedure: Publishers and editors submit serial content to be considered for inclusion in Scopus, such as book series, conference proceedings, and journals. The material is scrutinized and selected in accordance with exacting and superior scientific criteria (Baas et al., 2020).

The bibliometric study revealed that 1,191 of the studies on common carp are from China, and the same is true for authors and academic institutions. With 19.2% of the world's marine capture fishery production and 61.5% of the world's aquaculture production in 2016, China leads the world in both capture fisheries and aquaculture production (FAO, 2018). China's

aquaculture industry has grown significantly over the last several decades, and since the 1990s, the nation has been the world's largest producer of aquaculture.

The past century has seen a surge in scientific research on aquaculture in China. China has had a well-established, comprehensive aquaculture research system for more than 40 years of aquaculture development. The primary components of the system are universities, research institutions financed by local governments, primarily provincial and municipal, and national fisheries research institutions funded by the federal government. The nation's fisheries research institute counted 210 in 1999.

The number of experts in science and technology who work full-time for the government (both local and central) in the fields of technological development and fisheries research (mostly aquaculture). The Chinese Academy of Fishery Sciences, which is directly under the Ministry of Agriculture, is in charge of managing national fisheries research institutions, which get funding from the Central Government (Figure 6). Province governments or the Ministry of Education are in charge of overseeing universities. China's primary sources of technological advancement and research capacity in aquaculture are its national research institutions and universities. Typically, they work on technical development and basic and applied research projects that address the needs of the country's aquaculture development (Hishamunda and Subasinghe, 2003).

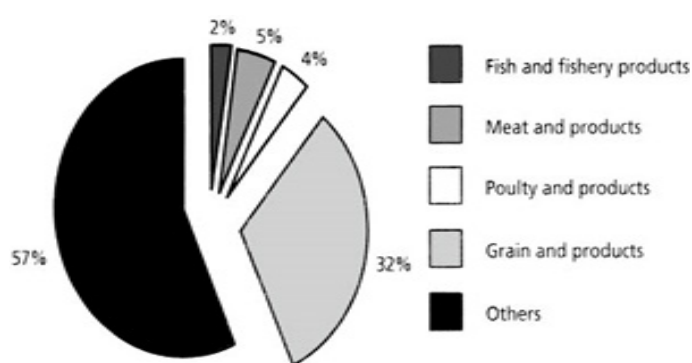


Figure 6: *The fish sales percentage at Beijing's grocery stores and fast-food businesses in 1998.*

Despite the wealth of scholarly research on China's aquaculture industry, much remains unclear regarding the country's sector's development. Specifically, there is a dearth of information regarding the causes and influences of aquaculture's growth in China. Their research may be very important for determining not

only how aquaculture will evolve in China but also for other regions of the world. Policies, socioeconomic growth, and a variety of human demands all have an impact on fish farming (Hishamunda and Subasinghe, 2003; Cao *et al.*, 2015; Zhao *et al.*, 2018). According to Zhao *et al.* (2018), China's fast economic expansion and rising food demand have aided in the development of aquaculture. The principle of "giving priority to aquaculture with simultaneous efforts in aquaculture, fishing and processing, taking measures in accordance with local conditions, with respective priorities" was officially established in 1986 by the Fishery Law of the People's Republic of China. This marked the official determination of China's fishery policy of "giving priority to aquaculture" (Standing Committee of the National People's Congress, 1986). China's aquaculture business grew quickly as a result of this policy (Li *et al.*, 2011). Conversely, the findings showed that the majority of research on grass carp was published in the periodical Fish and Shellfish Immunology, with Aquaculture coming in second. Perhaps the reason is that the Cite-Score is high (9.0 and 7.9, respectively) compared to the rest of the magazines. This is of course due to the original research with new results and a quality close to the articles of researchers in the world.

The present results show that forming partnerships typically enhanced the research's impact (Figure 4). Even yet, there is a long history of cooperation between nations and institutions. As a result, it is obvious that better collaboration in this field is required, both nationally and internationally, as well as more effective information and experience sharing. As noted by Pikitch *et al.* (2005), expanding grass carp research to a wider and multidisciplinary scope should be the primary goal of future study. Targeted research and monitoring initiatives can best support future management actions.

Conclusions and Recommendations

The results of this analysis showed a consistent rise in the number of papers published on grass carp research. This is related to the increasing number of researchers dealing with grass carp research, whether by increasing individual productivity or the implications of the introduction of this species in most countries, which is considered an exotic and invasive fish, as in USA. However, grass carp research publications over the past ten years have come mostly from China and

the United States of America, as well as from some other productive countries. China also had a sharp increase in the number of publications it produced, which is not unexpected given that it is currently the world's top producer of grass carp aquaculture (Yue *et al.*, 2024) and actively fosters global collaboration. Inland production in 2016/2020 reached approximately 94.4%. In overall, some countries emerged with remarkable progress, as in some European and Latin American countries. There were also clear contributions from Arab countries, as in Egypt and Iraq, and in general. Consequently, there is a declared need to foster national and international cooperation in this field and to improve the efficacy of knowledge and experience exchange. Future research goals should focus primarily on expanding the scope of grass carp research to include a wider range of disciplines and, in particular, dedicating more resources to the study of severely endangered species that have received less attention in the past.

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Novelty Statement

Highlighting grass carp reflects the interest of fish farmers as well as researchers in the value of this species. However, this research evaluated to investigate the potential of scientific research to support all aspects related to this commercial species that consumers desire in the field of food security.

Author's Contribution

The author wrote all sections of the research.

Duality of interest

The author declares that he has no duality of interest associated with this manuscript.

References

- Aksnes, D.W. and Browman, H.I. 2016. An overview of global research effort in fisheries science. *ICES J. Mar. Sci.*, 73(4): 1004-1011. <https://doi.org/10.1093/icesjms/fsv248>
- Baas, J., Schotten, M., Plume, A., Côté, G. and Ka-

- rimi, R. 2020. Scopus as a curated, high-quality bibliometric data source for academic research in quantitative science studies. *Quant. Sci. Stud.*, 1(1): 377-386. https://doi.org/10.1162/qss_a_00019
- Bertocci, F. and Mannino, G. 2022. Can agri-food waste be a sustainable alternative in aquaculture? A bibliometric and meta-analytic study on growth performance, innate immune system, and antioxidant defenses. *Foods*, 11(13): 1861. https://doi.org/10.1162/qss_a_00019
- Bettoli, P.W., Maceina, M.J., Noble, R.L. and Bettisill, R.K. 1993. Response of a reservoir fish community to aquatic vegetation removal. *North Americ. J. Fisher. Manag.*, 13: 110-124. [https://doi.org/10.1577/1548-8675\(1993\)013%3C0110:ROARFC%3E2.3.CO;2](https://doi.org/10.1577/1548-8675(1993)013%3C0110:ROARFC%3E2.3.CO;2)
- Bozkurt, Y., Yavas, İ., Gül, A., Balci, B.A. and Çetin, N.C. 2017. Importance of grass carp (*Ctenopharyngodon idella*) for controlling of aquatic vegetation. In: Almusaed, A. & Al-Samarraee, S.M.S. (Eds). *Grasses: Benefits, diversities and functional roles*: 29- 39. <https://doi.org/10.5772/intechopen.69192>
- Braun, T., Glänzel, W. and Schubert, A. 2006. A Hirsch-type index for journals. *Scientometrics*, 69(1): 169-173. <https://doi.org/10.1007/s11192-006-0147-4>
- Cao, L., Naylor, R., Henriksson, P., Leadbitter, D., Metian, M. and Troell, M. 2015. China's aquaculture and the world's wild fisheries. *Science*, 347: 133-135. <https://doi.org/10.1126/science.1260149>
- Chilton, E.W. and Muoneke, M.I. 1992. Biology and management of grass carp (*Ctenopharyngodon idella*, Cyprinidae) for vegetation control: a North American perspective. *Reviews in fish biology and fisheries*, 2: 283-320. <https://doi.org/10.1007/BF00043520>
- Colle, D.E., Shireman, J.V. and Rottmann, R.W. 1978. Food selection by grass carp fingerlings in a vegetated pond. *Transac. Americ. Fisher. Soc.*, 107: 149-152. [https://doi.org/10.1577/1548-8659\(1978\)107%3C149:FSBGC%3E2.0.CO;2](https://doi.org/10.1577/1548-8659(1978)107%3C149:FSBGC%3E2.0.CO;2)
- Costa, D.F., De melo Carvalho, F., De melo Moreira, B.C. and Do prado, J.W. 2017. Bibliometric analysis on the association between behavioral finance and decision making with cognitive biases such as overconfidence, anchoring effect and confirmation bias. *Scientometrics*, 111:

- 1775-1799. <https://doi.org/10.1007/s11192-017-2371-5>
- Dibble, E.D. and Kovalenko, K. 2009. Ecological impact of grass carp: a review of the available data. *J. Aquat. Plant Manag.*, 47(1): 1-15.
- Dick, G.O., Smith, D.H., Schad, A.N. and Owens, C.S. 2016. Native aquatic vegetation establishment in the presence of triploid grass carp. *Lake and Reservoir Management*, 32(3): 225-233. <https://doi.org/10.1080/10402381.2016.1167147>
- FAMA (Fisheries administration of the ministry of agriculture and rural affairs of the People's Republic of China). 2022. China fisheries statistics yearbook. China Agricultural Press.
- FAO, 2012. The state of world fisheries and aquaculture. Food and agriculture organization of the United Nation. Rome: 238.pp.
- FAO, 2018. Fisheries and aquaculture department). 2018. The state of world fisheries and aquaculture: Meeting the sustainable development goals. FAO. <https://www.fao.org/about/meetings/en/>
- FAO, 2020. The state of world fisheries and aquaculture. Sustainability in action. Rome. <https://doi.org/10.4060/ca9229en>
- Fujii, H., Sakakura, Y., Hagiwara, A., Bostock, J., Soyano, K. and Matsushita, Y. 2017. Research and development strategy for fishery technology innovation for sustainable fishery resource management in north-east Asia. *Sustainability*, 10(1): 59. <https://doi.org/10.3390/su10010059>
- Gauffriau, M., Larsen, P.O., Maye, I., Roulin-perriard, A. and Von ins, M. 2007. Publication, co-operation and productivity measures in scientific research. *Scientometrics*, 73(2): 175-214. <https://doi.org/10.1007/s11192-007-1800-2>
- Hirsch, J.E. 2010. An index to quantify an individual's scientific research output that takes into account the effect of multiple coauthorship. *Scient metrics*, 85: 741-754. <https://doi.org/10.1007/s11192-010-0193-9>
- Hirsch, J.E. 2005. An index to quantify an individual's scientific research output. *Proceedings of the National academy of Sciences*, 102(46): 16569-16572. <https://doi.org/10.1073/pnas.0507655102>
- Hishamunda, N. and Subasinghe, R.P. 2003. Aquaculture development in China: the role of public sector policies (No. 427). Food and Agriculture Org.
- Hsieh, W.H., Chiu, W.T., Lee, Y.S., and Ho, Y.S. 2004. Bibliometric analysis of patent ductus arteriosus treatments. *Scientometrics*, 60(2): 105-215.
- Jarić, I., Cvijanović, G., Knežević-jarić, J. and Lenhardt, M. 2012. Trends in fisheries science from 2000 to 2009: A bibliometric study. *Reviews in Fisheries Science*, 20(2): 70-79. <https://doi.org/10.1080/10641262.2012.659775>
- Jones, L.A., Mandrak, N.E. and Cudmore, B. 2017. Updated (2003-2015) biological synopsis of grass carp (*Ctenopharyngodon idella*). DFO Can. Sci. Advis. Sec. Res. Doc., 2016/102; Ottawa, ON, pp. 63.
- Kenney, M. 1988. Biotechnology: The University Industrial Complex. New Haven, CT: Yale University Press.
- Kunti, A.K. 2023. Understanding the significance of scopus indexing for academic journals. Medium, Available: <https://medium.com/@ajaykumarkunti13/understanding-the-significance-of-scopus-indexing-for-academic-journals-9e78c75042ce>
- Li, X., Li, J., Wang, Y., Fu, L., Fu, Y. and Li, B. 2011. Aquaculture industry in China: current state, challenges, and outlook. *Rev. Fisher. Sci.*, 19: 187-200. <https://doi.org/10.1080/10641262.2011.573597>
- Liu, J.M., Setiazi, H. and So, P.Y. 2023. Fisheries hydroacoustic assessment: A bibliometric analysis and direction for future research towards a blue economy. *Reg. Stud. Marine Sci.*, 60: 102838. <https://doi.org/10.1016/j.rsma.2023.102838>
- Mitzner, L. 1978. Evaluation of biological control of nuisance aquatic vegetation by grass carp. *Transactions Americ. Fisher. Soc.*, 107: 135-145. [https://doi.org/10.1577/1548-8659\(1978\)107%3C135:EOBCON%3E2.0.CO;2](https://doi.org/10.1577/1548-8659(1978)107%3C135:EOBCON%3E2.0.CO;2)
- Morris, J.E. and Clayton, R.D. 2006. Best management practices for aquatic vegetation management in lakes. In 11th Triennial National Wildlife & Fisheries Extension Specialists Conference (2006) (pp. 24).
- Mongeon, P., and Paul-Hus, A. 2016. The journal coverage of Web of Science and Scopus: a comparative analysis. *Scientometrics*, 106: 213-228.
- Murray, F. 2002. Innovation as co-evolution of scientific and technological networks: exploring tissue engineering. *Res. Pol.*, 31: 1389-1403. [https://doi.org/10.1016/S0048-7333\(02\)00070-7](https://doi.org/10.1016/S0048-7333(02)00070-7)

- Natale, F., Fiore, G. and Hofherr, J. 2012. Mapping the research on aquaculture. A bibliometric analysis of aquaculture literature. *Scientometrics*, 90(3): 983-999. <https://doi.org/10.1007/s11192-011-0562-z>
- National Science Board 2014. Science and engineering indicators 2014. National Science Foundation, Arlington, VA.
- Neff, M. and Corley E. 2009. 35 years and 160,000 articles: A bibliometric exploration of the evolution of ecology. *Scientometrics*, 80(3): 657-682. <https://doi.org/10.1007/s11192-008-2099-3>
- Pham-Duc, B., Nguyen, H., Le Minh, C., Khanh, L.H., and Trung, T. 2020. A bibliometric and content analysis of articles in remote sensing from Vietnam indexed in Scopus for the 2000-2019 period. *Serials Review*, 46(4): 275-285.
- Pikitch, E.K., Doukakis, P., Lauck, L., Chakrabarty, P., Erickson and D.L. 2005. Status, trends and management of sturgeon and paddlefish fisheries. *Fish and Fisheries*, 6: 233-265. <https://doi.org/10.1111/j.1467-2979.2005.00190.x>
- Pipalova, I.A. 2006. Review of grass carp use for aquatic weed control and its impact on water bodies. *J. Aquat. Plant Manag.*, 44: 1-12.
- Prabakusuma, A.S., Wardono, B., Fahlevi, M., Zuhaim, A., Sunarno, M.T.D., Syukur, M. and Pramoda, R. 2023. A bibliometric approach to understanding the recent development of self-sufficient fish feed production utilizing agri-food wastes and by-products towards sustainable aquaculture. *Heliyon*, e17573. <https://doi.org/10.1016/j.heliyon.2023.e17573>
- Qaiser, F.H., Ahmed, K., Sykora, M., Choudhary and A., Simpson, M. 2017. Decision support systems for sustainable logistics: a review and bibliometric analysis. *Indust. Manag. Data Sys.*, 117(7): 1376-1388. <https://doi.org/10.1108/IMDS-09-2016-0410>
- Qiu H. and Chen, Y.F. 2009. Bibliometric analysis of biological invasions research during the period of 1991 to 2007. *Scientometrics*, 81(3): 601-610. <https://doi.org/10.1007/s11192-008-2207-4>
- Smith, J.O. and Powell, W. 2004. Knowledge networks in the Boston biotechnology community. *Org. Sci.*, 15: 5-21. <https://doi.org/10.1287/orsc.1030.0054>
- Standing Committee of The National People's Congress 1986. Fisheries law of the people's republic of China. China: Ministry of ecology and environment the People's Republic of China.
- Taher, M.M. 2022. Effects of water temperature on growth criteria of fingerlings of grass carp, *Ctenopharyngodon idella* (Valenciennes, 1884). *Biol. Appl. Env. Res.*, 6(1): 81-89. <https://doi.org/10.51304/baer.2022.6.1.81>
- Tan, M. and Armbruster, J.W. 2018. Phylogenetic classification of extant genera of fishes of the order *Cypriniformes* (Teleostei: *Ostariophysi*). *Zootaxa*, 4476(1): 6-39. <https://doi.org/10.11646/zootaxa.4476.1.4>
- Whittington, K.B., Owen-Smith, J. and Powell, W.W. 2009. Networks, propinquity, and innovation in knowledge-intensive industries. *Admin. Sci. Quarterly*, 54: 90-122. <https://doi.org/10.2189/asqu.2009.54.1.90>
- Wildhaber, M.L., West, B.M., Ditter, K.K., Moore, A.P. and Peterson A.S. 2023. A review of grass carp and related species literature on diet, behavior, toxicology, and physiology focused on informing development of controls for invasive grass carp populations in North America. *Fishes*, 8(11): 547. <https://doi.org/10.3390/fishes8110547>
- Wittmann, M.E., Jerde, C.L., Howeth, J.G., Mahler, S.P., Deines, A.M., Jenkins, J.A. and Lodge, D.M. 2014. Grass carp in the Great Lakes region: establishment potential, expert perceptions, and re-evaluation of experimental evidence of ecological impact. *Canadian J. Fisher. Aquat. Sci.*, 71(7): 992-999. <https://doi.org/10.1139/cjfas-2013-0537>
- Xie, H., Wen, Y., Choi, Y. and Zhang, X. 2021. Global trends on food security research: A bibliometric analysis. *Land*, 10(2): 119. <https://doi.org/10.3390/land10020119>
- Yue, G.H., Tay, Y.X., Wong, J., Shen, Y. and Xia, J. 2024. Aquaculture species diversification in China. *Aquacult. Fisher.*, 9(2): 206-217. <https://doi.org/10.1016/j.aaf.2022.12.001>
- Zhao, K., Molinos, J.G., Zhang H., Jun M. and Xu J. 2018. Contemporary changes in structural dynamics and socioeconomic drivers of inland fishery in China. *Sci. total Envir.*, 648: 1527-1535. <https://doi.org/10.1016/j.scitotenv.2018.08.196>
- Zhu, S., Jin, W. and He, C. 2019. On evolutionary economic geography: A literature review using bibliometric analysis. *European Planning Studies*, 27(4): 639-660. <https://doi.org/10.1080/09>

654313.2019.1568395

- LeRoy, J.Z., Doyle, H.F., Jackson, P.R. and Cigrand, C.V. 2024. Reproduction of grass carp (*Ctenopharyngodon idella*) in the Maumee River, Ohio: Part 2—Optimal River conditions for egg and larval drift. *J. Great Lakes Res.*, 50(3): 102345. <https://doi.org/10.1016/j.jglr.2024.102345>
- Wu, S., Wang, G., Angert, E.R., Wang, W., Li, W. and Zou, H. 2012. Composition, diversity, and origin of the bacterial community in grass carp intestine. *PloS one*, 7(2): e30440. <https://doi.org/10.1371/journal.pone.0030440>
- Ni, D.S. and Wang, J.G. 1999. *Biology and diseases of grass carp*. Science press, Beijing China.
- Sifa, L., Hequan, Y and Weimin, L. 2014. Preliminary research on diurnal feeding rhythm and the daily ration for silver carp, bighead carp and grass carp. *J. Fisher. China*, 4(3): 275-284.
- Li, L., Balto, G., Xu, X., Shen, Y. and Li, J. 2023. The feeding ecology of grass carp: a review. *Rev. Aquacult.*, 15(4): 1335-1354. <https://doi.org/10.1111/raq.12777>
- Wang, Y., Liu, W., Li, Z., Qiu, B., Li, J., Geng, G. and Liu, S. 2024. Improvement and application of genetic resources of grass carp (*Ctenopharyngodon idella*). *Reprod. Breed.*, 4(3): 126-133. <https://doi.org/10.1016/j.repbre.2024.04.003>
- Ji, M., Wang, B., Xie, J., Wang, G., Yu, E., Jiang, P. and Tian, J. 2024. Effects of low protein feed on hepato-intestinal health and muscle quality of grass carp (*Ctenopharyngodon idellus*). *Comparative Biochemistry and Physiology Part B: Biochemistry and Molecular Biology*, 273: 110989. <https://doi.org/10.1016/j.cbpb.2024.110989>
- Sutton, D.L., Vandiver, V.V. and Hill, J. 1986. *Grass carp: A fish for biological management of hydrilla and other aquatic weeds in Florida*. Agricultural experiment stations, Institute of food and agricultural sciences, University of Florida.