

FISH NUTRITION: BIBLIOMETRIC ANALYSIS IN BRAZIL AND THE WORLD

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ABSTRACT

The Science of fish nutrition is an important issue and of great importance from the point of view of developing new diets with respect to the nutritional requirements of various fish species and the environment, with many published articles addressing the subject. The objective of this study was to make a bibliometric analysis to identify trends in publications worldwide and in Brazil. Took place during the month of December 2011, searches the Scopus base and recorded information related to the main countries, authors, publishing and institutions vehicles. The study revealed that Brazil, besides occupying Featured number of articles on the subject, including having a center of excellence in the subject, presented high growth rates of articles, compared to global rates. Further, it was found that most of the articles on the topic is concentrated in a few authors, institutions and journals.

Keyword: Food; Bibliometrics; Research; Fish Farming.

RESUMO

A nutrição de peixes é uma importante área e de grande relevância do ponto de vista do desenvolvimento de novas dietas com relação às exigências nutricionais de diversas espécies de peixes e do ambiente, com muitos artigos publicados abordando o assunto. O objetivo deste estudo foi fazer uma análise bibliométrica para identificar tendências em publicações em todo o mundo e no Brasil. Foi realizado durante o mês de Dezembro de 2011, uma busca na base Scopus e informações registradas relacionadas com os principais veículos de países, autores, editoras e instituições que publicam sobre esse tema. O estudo revelou que o Brasil, ocupa uma posição de destaque na publicação de artigos sobre o assunto, indicando ser um centro de excelência no assunto, apresentado altas taxas de crescimento de artigos, em comparação com as taxas globais. Além disso, verificou-se que a maioria dos artigos sobre o tema concentra-se em poucos autores, instituições e revistas.

Palavras-chave: Alimentos; Bibliometria; Pesquisa; Criação de peixes.

1 Introduction

Fish farming requires the adoption of managed breeding systems in intensive systems where nutrition plays the most important role, requiring serious efforts of research for the generation of appropriate technologies. The few surveys so far conducted in the country on the subject deal, mostly the result of adaptations of international research to our conditions (PORTZ, 2001).

The fish nutrition is a science that has been growing steadily due to various factors, such as growth of the world and national aquaculture, new species of potential fish for fish farming, industry by-products of use to feed formulations, achieve better digestibility coefficients, greater environmental responsibility, among other factors (COLT, MONTGOMERY, 1991; PORTZ, 2001; WATANABE et al., 1991). Research in this area are important for the development of fish farming in Brazil and worldwide (OLIVEIRA; DÓREA; DOMENE, 1992; PORTZ, 2001).

Thus, the qualitative and quantitative analysis of publications on a particular subject is an indicator of the relative importance attached to this issue (ARAÚJO, 2006; BOUSTANY, 1997; FONSECA, 1986). A science that has attracted most attention recently is bibliometrics (PINHEIRO, 1983). From this it is possible, by applying statistical methods to make findings about the state of a given art, science or business (PRITCHARD, 1969; ROSTAING, 1996; TAGUE-SUTCKIFFE, 1992).

The objective of this study was therefore to carry out a bibliometric study using the Scopus search base, on the subject nutrition of fish, both in Brazil and in the world and presented the evolution and countries, authors, institutions and journals What else have published on the subject.

2 Material and Methods

The data used in this study were obtained from the base of search scientific articles Scopus, available on Portal Journals Capes. The search was held on December 17, 2011, and used the option of quick search, which returns the publications that have the word you typed in the title, abstract or keywords.

Information regarding the temporal evolution, name of authors, journal, affiliation and country were obtained in the fields where you can refine the search.

For temporal analysis were exponential regression equations the number of publications under the year. The values of each variable were linearized by applying logarithm so that the slope of the equation indicates the growth rate in a given period.

The concentration analysis was performed by comparing the number of publications of the top 10 contributors (countries, authors, institution or journal) out of the total of publications between the years 2000 to 2010.

3 Results and discussion

Looking at Figure 1, it is clear that Brazil has, in the course of time, increased their percentage share in the total number of publications compared to the world. In 2000, the Brazilian papers accounted for approximately 1.25% of total production in the world. In 2010, Brazil published around 2.3% of the world's goods, and the Brazilian representative has shown exponential growth.

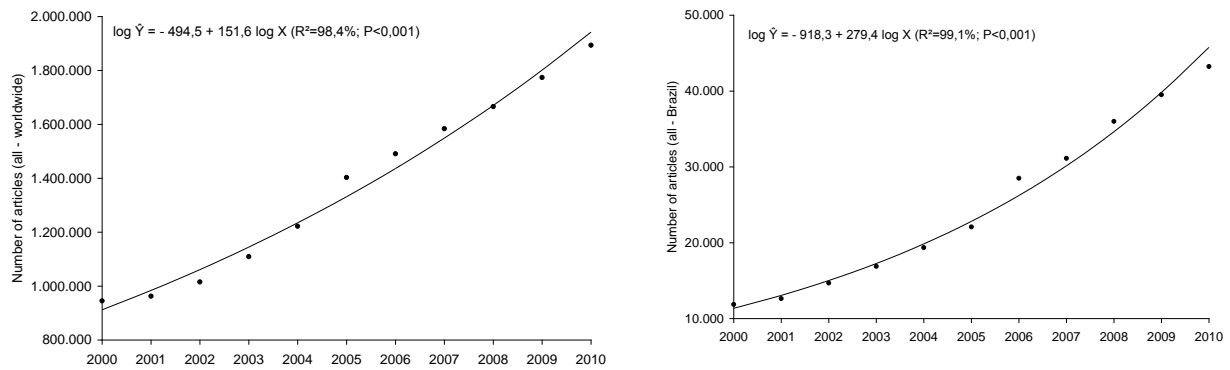


Figure 1: Evolution of the number of total publications in the world and in Brazil during the period 2000 to 2010.

3.1 Articles by country - concentration and temporal

Analysis Table 1 shows the 10 countries that have published articles in the world, both in general (fish), as those specific about fish nutrition. One can see that the United States and the United Kingdom are the ones who produce scientific articles. Although the UK take second place in publications with fish nutrition and fish, this is still well below the number of posts compared to the United States.

Brazil is in 10th place in the scientific production of articles in the fish area, but when you look at the scientific production in fish nutrition area, it occupies the 7th place as seen in Table 1, one explanation for this increase is the need to research the nutritional requirements of new species of native fish, with great potential for the Brazilian fish farming.

Table 1: Countries most published articles in Scopus, in the area of fish and fish nutrition.

Fish		Fish Nutrition	
Country	Nº	Country	Nº
United States	34142	United States	321
United Kingdom	9879	United Kingdom	117
Canada	9257	Spain	97
Japan	8731	France	93
Australia	5920	Australia	78
France	5212	Canada	76
Spain	4976	Brazil	71
Germany	4856	Norway	71
Norway	4687	Germany	59
Brazil	3690	Italy	50

Figure 2 shows the evolution of the number of articles related to publications with fish and fish nutrition in the world from 2000 to 2010, demonstrating that the publications in the world regarding fish had a linear growth, unlike when observing the publications fish nutrition had a very large fluctuation in recent years and may be inferred that the continuation of research in fish nutrition area was not very efficient in the private and public incentives.

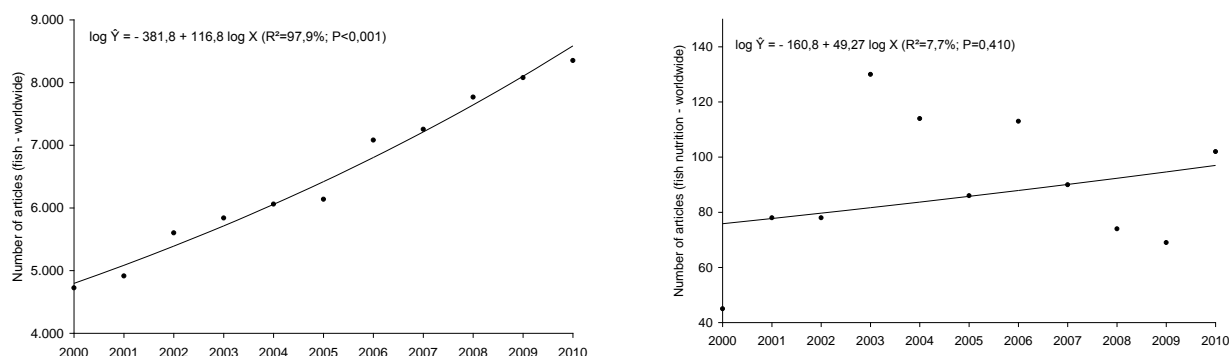


Figure 2: Evolution of the number of publications on the subject of fish nutrition and fish during the period 2000 to 2010 in the world.

3.2 Articles per author - concentration

Table 2 presents the main authors who have published articles on fish and fish nutrition in Brazil and worldwide. It is noticed that, despite Brazil have good participation in related publications to the subject, yet there is a great concentration of articles concentrated in a few authors. This information demonstrates the great difficulty of newly doctors to raise funds in development agencies to join the search, even as their resumes are not compatible with traditional and well-established researchers.

Table 2: Key authors who have published articles about the area of fish and fish nutrition in Brazil and worldwide.

Fish		Fish – Brazil		Fish Nutrition		Fish Nutrition - Brazil	
Author	Nº	Author	Nº	Author	Nº	Author	Nº
Wood, C.M.	210	Oliveira, C.	56	Gatlin, D.M.	12	Pezzato, L.E.	8
Moravec, F.	202	Bertollo, L.A.C.	55	Shiau, S.Y.	11	Barros, M.M.	6
Dabrowski, K.	144	Agostinho, A.A.	54	Kaushik, S.J.	9	Donzele, J.L.	6
Klesius, P.H.	132	Foresti, F.	53	Donzele, J.L.	9	Goncalves, G.S.	5
Benjakul, S.	129	Baldisserotto, B.	52	Pezzato, L.E.	9	Guimaraes, I.G.	4
Johnston, I.A.	128	Sazima, I.	45	Williams, K.C.	9	Boscolo, W.R.	4
Cooke, S.J.	119	Val, A.L.	43	Allan, G.L.	8	Cyrino, J.E.P.	4
Farrell, A.P.	117	Moreira-Filho, O.	42	Conceicao, L.E.C.	8	Feiden, A.	3
Potter, I.C.	113	Takemoto, R.M.	39	Bell, J.G.	8	Moraes, G.	3
Gatlin, D.M.	113	Luque, J.L.	38	Dick, J.R.	8	Chagas, E.C.	3

In 2000, Brazil accounted for approximately 2.5% of the total number of publications related to fish, compared to the rest of the world, in 2010 the investment is now approximately 6%, showing that interest in research in the area of fish has increased greatly over the last 10 years, but nothing compared to the increase of production in the country was close to 10% per year.

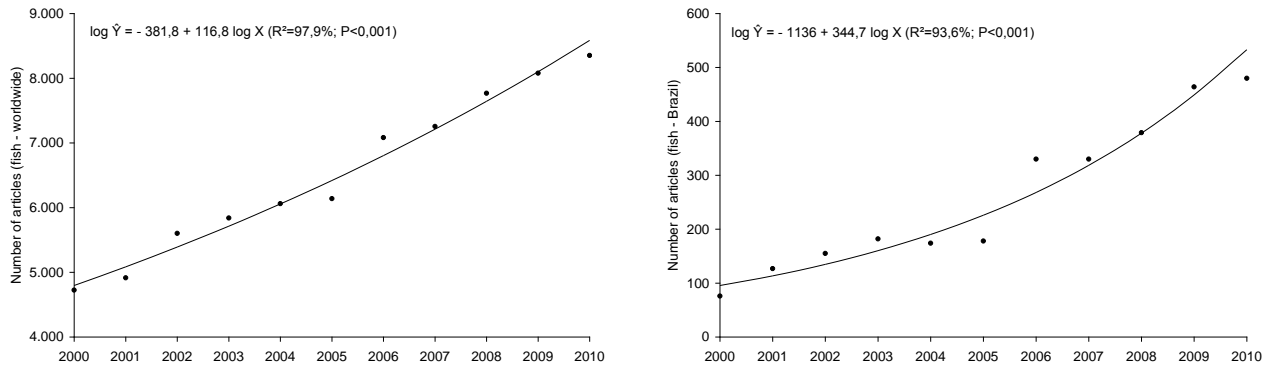


Figure 3: Evolution of the number of fish theme relates to publications in the world and in Brazil during the period from 2000 to 2010.

3.3 Publishing vehicle (journal, conference proceedings, etc.)

Table 3 shows the major magazines that are published work on fish and fish nutrition in the world and in Brazil.

Table 3: Main vehicles more published about fish and fish nutrition in the world and in Brazil.

Fish		Fish – Brazil		Fish Nutrition		Fish Nutrition – Brazil	
Periodic	Nº	Periodic	Nº	Periodic	Nº	Periodic	Nº
Aquaculture	5998	Neotrop. ichthyol.	216	Aquaculture	153	Rev. bras. zootec.	21
J. fish biol.	4819	Braz. j. biol.	205	Hydrobiologia	78	Hydrob.	8
Environ. biol. Fishes	2884	Acta sci., Biol. sci.	167	Aquac. res.	50	PAB	5
Hydrob.	2422	J. fish biol.	139	Aquac. nutr.	47	Aquaculture	4
Nature	2384	Rev. bras. zootec.	117	Lipids	47	Cienc. rural	4
Mar. ecol., Prog. ser.	2012	Aquaculture	90	J. Great Lakes res.	46	Sci. agric.	3
Can. j. fish. aquat. sci.	1872	Environ. biol. fishes	88	Am. j. clin. nutr.	40	Acta sci., Anim. sci.	3
Fish. res.	1711	Genetica	78	J. Am. Diet. Assoc.	40	Aquac. res.	3
J. Exp. Biol.	1704	Hydrob.	76	J. nutr.	31	Acta sci., Biol. sci.	2
Aquac. res.	1625	Caryologia	67	Rev. bras. zootec.	27	Aquac. nutr.	2

This information is especially important in order to choose which publication vehicle to submit an article. As noted, the magazine that have more articles on fish and fish nutrition in the world is the Aquaculture, different publications in Brazil, in the area of fish and fish nutrition this magazine is in sixth and fourth place respectively. Several publications in the areas of fish and fish nutrition in Brazil are in multidisciplinary journals, unlike most of the publications in the same area in the rest of the world, who choose to journals in aquaculture area. This is a practice that may hinder the diffusion of relevant work in the area of interest.

By Figure 4 we can see that in Brazil in 2000 to participate in publications was approximately 2.5%, while in 2010 was 18%, showing that the interest of researchers and funding agencies to define research nutritional requirements of the species native to Brazil caused the growth of publications in the grow area, highlighting Brazil on the world stage.

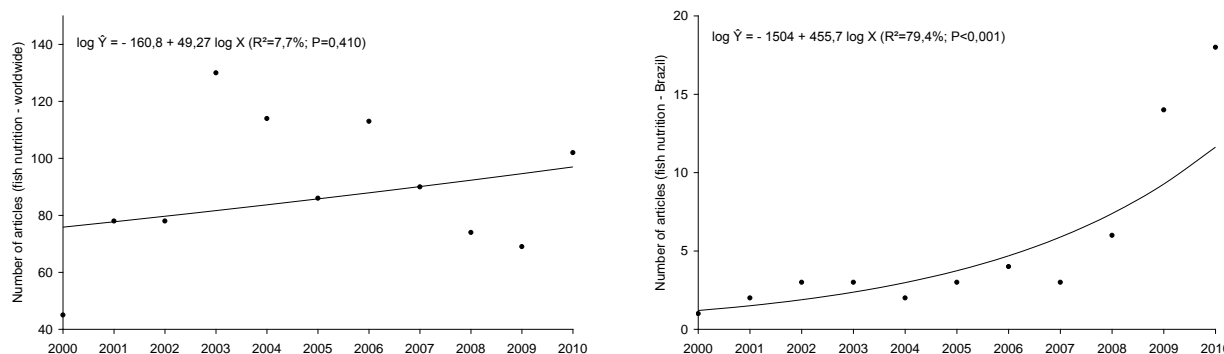


Figure 4: Evolution of the number of fish nutrition issue of respect to publications in the world and in Brazil during the period 2000 to 2010.

3.4 Articles by the institution – concentration

Table 4 shows that most institutions have published about fish and nutrition fish in the world and in Brazil. Interestingly, the institution that stands out in the world with publications in fish nutrition area is the UNESP, ranking third, as in Brazil ranking first, making a reference centre in fish nutrition area in Brazil and in the world. Another aspect that can be noted is that when it comes to the subject fish to publications, no Brazilian institution appears among the 10 that publish more, showing that Brazil is still far behind the world stage when it comes to fish with publications. Still, you can see the extreme concentration of articles around the few institutions in Brazil.

Table 4: Major institutions that more published about fish and fish nutrition in Brazil and worldwide.

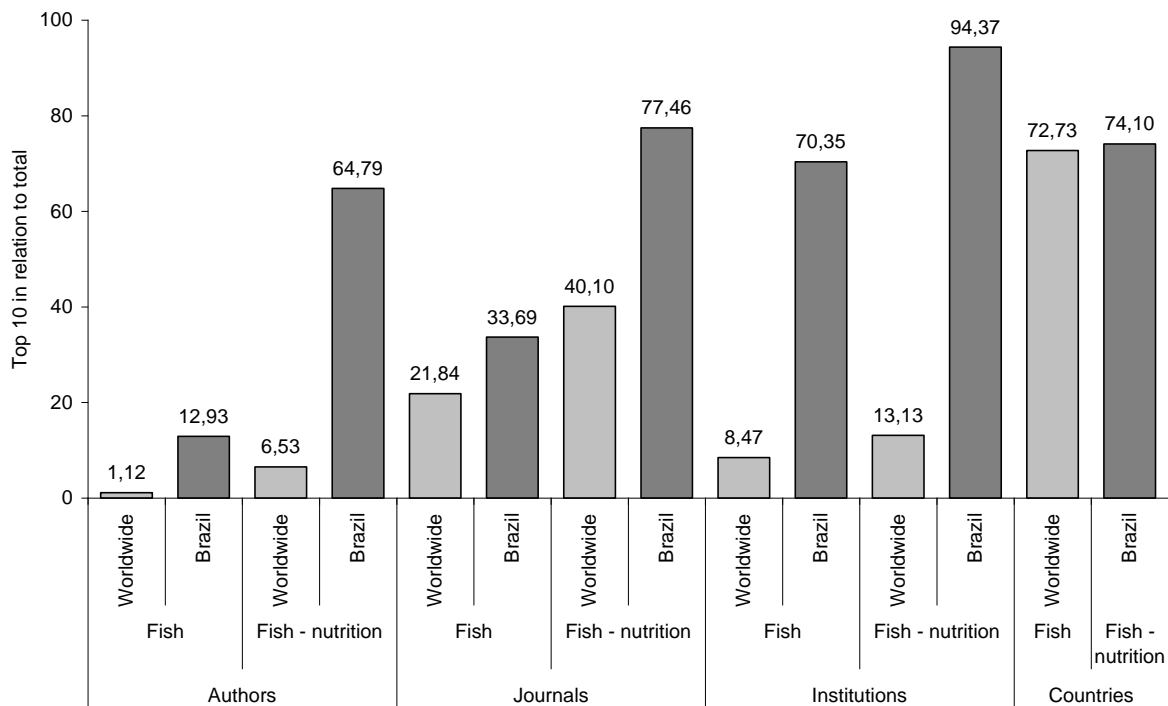
Fish		Fish – Brazil		Fish Nutrition		Fish Nutrition – Brazil	
Institution	Nº	Institution	Nº	Institution	Nº	Institution	Nº
Hokkaido Un.	1289	UNESP	571	Un. Stirling	28	UNESP	18
Un. Washington	1175	USP	448	NIFES	21	UEM	9
Un. British Columbia	1136	UEM	342	UNESP	20	Inst. Pesca	7
Un. Tokyo	1119	UFSCar	251	US Geol. Survey	19	USP	6
US Geol. Survey	1080	INPA	247	CSIRO	18	Unioeste	5
IMR	1074	UFRJ	174	Texas Un.	16	UFV	5
UC Davis	1016	Unicamp	158	Taiwan Ocean Un.	16	INPA	5
Oregon State Un.	967	UFPR	156	INRA – IFREMER	16	UFRJ	4
Tokyo Un. Mar. Sc.	899	UFSC	131	Univers. Bergen	15	Embrapa	4
Univers. Bergen	884	UFRGS	118	Un. Algarve	14	Governo SP	4

From Chart 1, we can see that the top 10 countries participated in approximately 72 publications and 74% in the areas of fish and fish nutrition, respectively. Demonstrating that research is highly concentrated in a few countries.

Top 10 Brazilian authors account for 64% of all national publications in fish nutrition area, publications in this area are directly related to a minority of researchers, and the part of nutritional requirements is an important basis for technology package of a new species of fish.

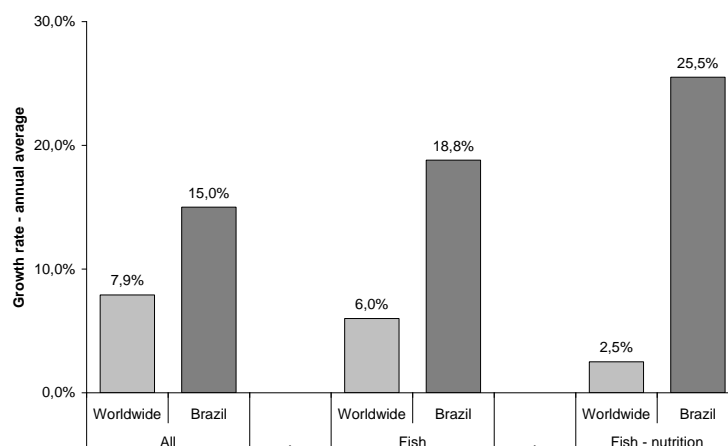
Another aspect that can be seen in chart 1, there is high concentration of Brazilian publications in fish nutrition area in major newspapers, magazines and the top 10 account for over 74% of the publications in this area. This result shows the major journals that researchers publish more of this evaluation by other researchers can be directed in which search or publish periodicals in the world or in Brazil in fish nutrition area.

The high concentration of publications in fish nutrition area in 10 leading journals, authors and countries is even greater when it evaluates the top 10 Brazilian institutions that publish in this area, from 94%, few institutions publish almost all Articles aimed at fish nutrition area, watching as soon as the encouragement to researchers and institutions to work the line of research on fish nutrition area is poorly distributed in Brazil.



Graph 1: Share (%) of publications of the top 10 authors, journals, institutions and countries on fish and fish nutrition in Brazil and worldwide.

From the exponential regression equations, it was prepared in Chart 2, which shows the annual average of growth rate. In 2000 to 2010, there was acceleration in the number of articles published in the world. In Brazil, the growth rate was much higher than in the world. The yearly growth rate in the world publications in fish nutrition area was 2.5%, while the Brazil was 25.5%, which is almost 10 times higher than the growth rate in the world. These data show how the scientific environment in fish nutrition area devoted to define the nutritional requirements of various species of exotic and native fish in Brazil. Research these important for the development of aquaculture, fastest growing sector in Brazil and the world.



Graph 2: Yearly growth rate (2000 – 2010) of the number of articles related to area of fish and fish nutrition in the world and in Brazil.

The degree of concentration of the articles published in the field of fish and fish nutrition of the top 10 authors, journals, institutions and countries in the world and in Brazil are presented in Table 5. It can observe that 12.93% of articles published in the fish area 10 were the authors who published, while in fish nutrition area close to this value is 65%, showing that in fish nutrition research area are more concentrated when compared to the fish area.

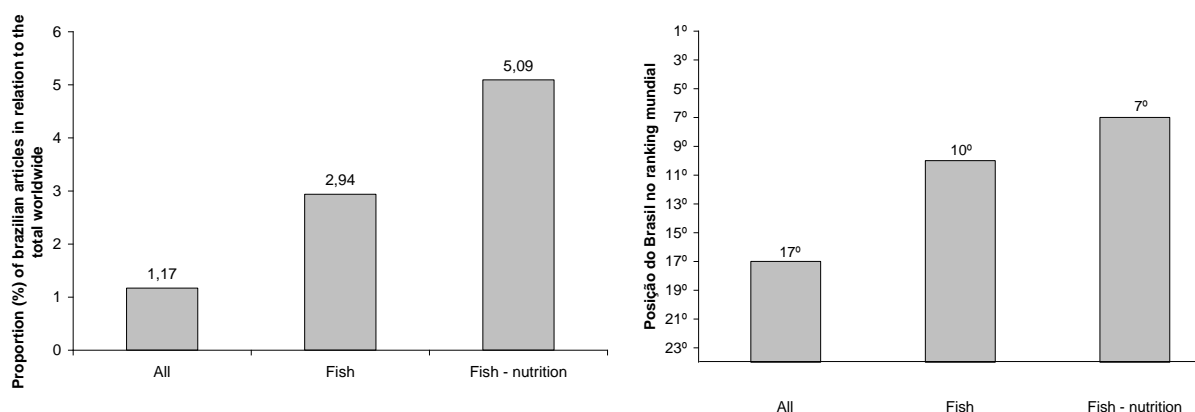
Table 5: The degree of concentration of the articles published in the field of fish and fish nutrition of the top 10 authors, journals, institutions and countries worldwide and Brazil.

Item	Parameter	Fish		Fish Nutrition	
		World	Brazil	World	Brazil
Authors	Total (10+)	1407	477	91	46
	Total	125598	3690	1394	71
	%(10+)	1,12	12,93	6,53	64,79
Journals	Total (10+)	27431	1243	559	55
	Total	125598	3690	1394	71
	%(10+)	21,84	33,69	40,10	77,46
Institution	Total (10+)	10639	2596	183	67
	Total	125598	3690	1394	71
	%(10+)	8,47	70,35	13,13	94,37
Country	Total (10+)	91350	-	1033	-
	Total	125598	-	1394	-
	%(10+)	72,73	-	74,10	-

The total number of publications in the world was of 33,950,910 articles (Table 6), and those Brazil had a share with 397,330 articles, representing 1.17% of the total published in the world, leaving Brazil in 17th of the countries that has published in this area, as can also be seen in graph 3. But when it comes to publications in fish nutrition area, Brazil occupies the 7th place of the countries that have published, that is, showing the great importance that the country has the global context in fish nutrition area.

Table 6: Participation (%) of publications in Brazil compared to the total published in the world in the areas of fish, fish nutrition and total publications.

Item	World N° articles	N° articles	Brazil %	Ranking
All	33950910	397330	1,17	17
Fish	125598	3690	2,94	10
Fish - nutrition	1394	71	5,09	7



Graph 3: Share (%) of the publications in Brazil compared to the total published worldwide in the areas of fish, fish nutrition and total publications.

Much research has to be developed in this area because most of the information available in the literature was obtained with species of cold water fish, whose reports cannot be adequately applied. The actual nutritional requirements of tropical fish species present unknown, which is probably the main challenge for the coming years and new researchers.

4 Conclusions

Based on bibliometric study on fish nutrition conducted, it was possible to obtain the following conclusions:

- The United States is the country that publishes more articles, while Brazil holds a prominent position in number of articles on the subject;
- Worldwide, the growth rate of articles has increased and, in Brazil, this growth rate is even higher, remaining high in recent years;
- Brazil's participation compared to world production in publications on the subject has increased exponentially;
- In Brazil, there is high concentration of articles in the top 10 authors, institutions and journals;
- Most of the articles on the subject in Brazil is published in the zootechnical field and in national magazines, contrary to Articles worldwide who are mostly published in journals in the field of fish nutrition and fish;
- Brazil has a university (UNESP) as a centre of excellence for publications in the area.

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