

## Scholarly publications on Astaxanthin: a quantitative mapping

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### Abstract

This paper is an attempt to analyses 5686 research publications indexed in Web of science core collection across the world on a phytoconstituents *i.e* Astaxanthin which is a keto-carotenoid pigment mainly accumulated by microalgae. These 5686 publications on Astaxanthin have been contributed by 15224 authors and received 159896 citations upto year 2021. The year 2021 was the most productive year with 598 publications on Astaxanthin. Journal Aquaculture is the most productive journal with 173 publications on Astaxanthin, China is the most contributing country with a 21.54 % share of global publication. Among the top 5 most productive institutions three belongs to China. English is the most preferred language for communication followed by Japanese and Spanish. Chen Feng from Peking University is the most productive author on Astaxanthin. 97 % of the publications are in collaboration and only 3 % publications have been contributed by Single author.

**Keywords:** Astaxanthin, Mapping, Natural compound, Scientometric, Tetraterpenoid

### Introduction

Astaxanthin is a lipid-soluble keto-carotenoid pigment which belongs to tetraterpenoid. Its IUPAC name is

3,3'-dihydroxy- $\beta,\beta$ -carotene-4,4'-dione. It was first isolated by Kuhn and Sorenson from a lobster<sup>1</sup> and was first synthesized in the year 1975. Astaxanthin is a metabolite of zeaxanthin and Canthaxanthin. Mostly it is found in red colour aquatic species. The microalgae *Haematococcus pluvialis* have been reported to accumulate the highest concentration of pigment Astaxanthin. Astaxanthin is primarily used as a dietary supplement and as a food colorant. In comparison to other carotenoids viz.  $\beta$ carotene and others Astaxanthin has been reported to possess higher antioxidant activity and therefore, also termed as super Vitamin E<sup>2</sup>. Bibliometric or Scientometric techniques is the most popular and widely used method to trace out the research and development activity on any given topic or research area. Previously bibliometric analysis of some natural compounds, journals, institutions, and countries have been investigated by a number of authors. Pathak & Prasanna (2019)<sup>1</sup> studied the trends of research on Quassinoids, and Zhang *et al* (2009)<sup>3</sup> studied research trends in volatile organic compounds. Anticancer natural products using PubMed data has been studied extensively by Du & Tang (2014)<sup>4</sup>. Pathak & Prasanna (2019)<sup>5</sup> investigated international collaboration in pharmaceutical sciences in India. The main objective of this study is to find out the trend in Astaxanthin research using scientometric techniques and find out the

yearwise growth of literature, leading authors, Journals, organizations, Authorship patterns & collaboration dynamics.

### Materials and Methods

Data for this study was collected from Science Citation Index Expanded (SCI-E) database of Web of Science core collection from Clarivate analytics, using the basic search feature in October 2022. The keyword used is "Astaxanthin" and publication and citation year was restricted upto 2021. The document under the category of correction, reprint, and retracted publication were excluded from the study. There were total of 5686 publications in Astaxanthins indexed in SCI Journals. All the results were downloaded in MS- excel for analysis. For data visualization software Vosviewer were used.

### Results and Discussion

Yearwise publications on Astaxanthin indexed in SCI journals reveals that there was only one publication in 1948 and upto 1955 there were only publications each year. Until the year 1988 there were publications less than

From the year 1989 there was a significant increase in the number of publications. From the year 2004 number of publications increased in three digits. In the year 2020 and 2021, the publications crossed 500. 53.54% of total publications appeared during the last eight years i.e 2014- 2021 (Fig. 1).

Analysis of source titles for Astaxanthin publications revealed that these articles have been published in 1420 source publications. Table 2 enlist the list of journals with more than 100 publications along with their impact factor according to JCR 2021 release. The most productive journal is Aquaculture with 173 publications followed by Bioresource Technology (153 publications), Marine drugs (137), Food Chemistry (108), Algal Research Biomass Biofuels and Bioproducts (106) and Journal of Agriculture and Food chemistry. 727 source publications have published only one article on

astaxanthin while 252 source titles published 2 articles each (Table 1).

These 5686 publications on Astaxanthin have been contributed by 15224 authors across the globe. Among the top 10 Authors, 4 are from Chinese organizations, 2 from Japan, and one from France, Germany, Norway, and Korea each. The most contributing author on Astaxanthin publication is Chen Feng from Peking University China with 98 publications, followed by Maoka Takashi from Kyoto Japan with 65 publications, G Sandman from Goethe Institute Germany 50 publications. Misawa Norihiko from Ishikawa Prefecture University Japan and Liu J from Peking University China have 44 publications each. On the basis of citations Chen Feng leads the list with 4638 citations with an average citations 47.3 per publication. However, on the basis of average citation per paper, Misawa Norihiko from Ishikawa prefecture University Japan leads the list with 51.36 citations per publication having 2260 citations for 44 publications (Table 2).

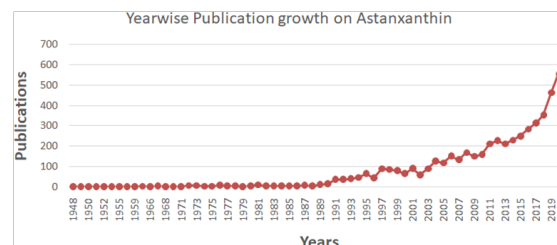


Fig. 1 Yearwise publication trends in Astaxanthin

Table 3 analyses the top 10 contributing organizations on Astaxanthin. Chinese Academy of

Sciences with 213 publications is the most productive organization followed by the Spanish Research Council, Spain (108), the University Of Chinese Academy of Sciences (98), Ocean University of China (92), Council of Scientific & Industrial Research CSIR India (75), University Of Hong Kong, H (69), Korea University, South Korea (68), Akvaforsk Genetics, Norway(63),

Norwegian University of Science Technology (63) and Qingdao National Laboratory for Marine Science & Technology, China (63). Among the top 10 organizations, 4 are from China, and one from Spain, India, Hongkong, and South Korea. There are two organization from Norway in the top 10 contributing organizations. Out of 75 publications from CSIR India, 60 publications are from CSIR-Central food technology and

Research Institute.

Authorship pattern in Astaxanthin reveals that single authorship publication is 3.14% of the total publication which also indicates that ~97% of the publications are in collaboration either in interinstitutional, intra-institutional or international

Table 1: Top 10 most productive journals

Sl. No	Journal	Impact Factor (JCR 2021)	Publications	Percentage
1	Aquaculture	5.135	173	3.043%
2	Bioresource Technology	11.889	152	2.673%
3	Marine Drugs	6.085	137	2.409%
4	Food Chemistry	9.231	108	1.899%
5	Algal Research Biomass Bio-fuels and Bioproducts	5.276	106	1.864%
6	Journal of Agricultural and Food Chemistry	5.895	106	1.864%

collaboration. Four author's publications have the highest number of publications (1027), followed by five author publications (916), Three author publications (889), and two author publications (623). Hyper-authorship in Astaxanthin publications have also been seen as there are as many as 43 authors in a publication. There are 2037 publications having more than five authors (ranging from six authors to as many as 43 authors). 64% of the publications are written by single authors to five author publications (Table 4).

Publications on Astaxanthin were available in as many as 13 languages. English is the most prevalent language with 5621 publications having 98.5% of the total publication output followed by Japanese and Spanish with 18 and 14 publications respectively. The other language of publications includes German (9), Chinese (7), Portuguese (6), and Turkish (3). There were two publications each in Korean and Polish languages. One publication each in French, Hungarian, Swedish, and Russian were also available (Table 5).

The country wise analysis of 5686 publications reveals that there are 72 countries. The highest number of publications was from the Peoples Republic of China with 1226 publications followed by Japan with 672 publications, the USA with 671 publications, South Korea with 343 publications, and Spain with 293 publications (Fig. 2).

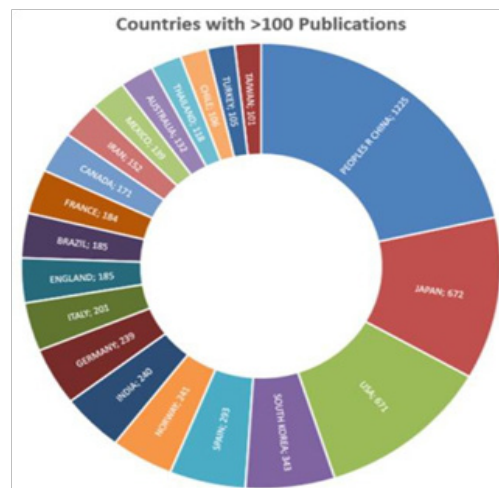


Fig. 2 Countrywise publication in Astaxanthin

Table 2 — Productive Authors and affiliation in Astaxanthin publication

Sl. No	Author	Organization	Publication	Citation	Average Citation
1	Chen Feng	Penkin Univeristy China	98	4638	47.33
2	Maoka Takashi	Res Inst Prod Dev, Sakyo, Kyoto, Japan	65	1659	25.52
3	Sandman Gerhard	Goethe University Frankfurt Inst Mol Biosci, Frankfurt, Germany	50	2122	42.44
4	Misawa Norihiko	Ishikawa Prefecture University, Res Inst Bioresources & Biotechnol, Nonoichi, Ishikawa, Japan	44	2260	51.36
5	Liu J	Peking Univesity	44	1723	39.16
6	Li Y	Chinese Academy of Sciences, Dalian Inst Chem Phys, Dalian, Peoples R China	42	727	17.31
7	Bjerkeng B	Norwegian Institute for Water Research (NIVA) OSLO, Norway	38	1672	44.00
8	Choubert, Georges	INRAE UMR Nutr Aquaculture & Genom 1067, ST Pee Sur Nivelle, France	38	1051	27.66
9	Sim SJ	Korea University	37	838	22.65
10	XU CH	Ocean University of China Coll Food Sci & Technol Qingdao, Shandong Provin, Peoples R China	37	404	10.92

Table 3 — Top 10 Organizations

Sl.No	Organization	Publication	% share
1	Chinese Academy of Sciences	213	3.746%
2	Consejo Superior De Investigaciones Cientificas CSIC (The Spanish Research council, Spain)	108	1.899%
3	University Of Chinese Academy of Sciences Cas	98	1.724%
4	Ocean University of China	92	1.618%
5	Council of Scientific & Industrial Research CSIR India	75	1.319%
6	University Of Hong Kong, HongKong	69	1.214%
7	.Korea University, South Korea	68	1.196%
8	Akvaforsk Genetics, Norway	63	1.108%
9	Norwegian University of Science Technology	63	1.108%
10	Qingdao National Laboratory for Marine Science & Technology, China	63	1.108%

Table 4. Authorship pattern of Publications on Astaxanthin

Authorship Pattern	Publications	Percentage
Single Author	194	341
Two Author	623	10.96
Three Author	889	15.63
Four Author	1027	18.06
Five Author	916	16.11
More than five author	2037	35.82

Table 5. Language wise publications on Astaxanthin

Language	Publications
English	5621
Japanese	18
Spanish	14
German	9
Chinese	7
Portuguese	6
Turkish	3
Korean	2
Polish	2
French	1
Russian	1
Swedish	1
Hungarian	1

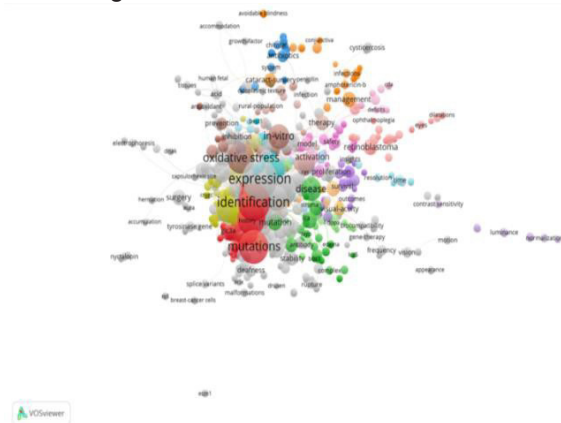


Fig. 3 — Keyword network of Astaxanthin publications

Figure 3 depicts the keyword network of Astaxanthin publications. There are 1743 keywords available in these 5686 publications on Astaxanthin. Out of these 1743 keywords 1554 items are connected to each other. The largest set of connected items These keywords are grouped into 51 clusters. The keyword expression

with 41 occurrences is the most frequent keyword followed by identification with 35 occurrences, mutations (29), gene (26), oxidative stress

(24) and locus (20). There are 76 keywords with more than 5 occurrences.

### Conclusion

It can be concluded from this study there is continuous growth in research & development activities on Astaxanthin across the globe. Most of the works are in collaboration which reveals that research on natural products are not individual-centric but requires a collaborative effort to achieve significant findings. In recent years focus on Astaxanthin has grown exponentially. China is leading the world on Astaxanthin. There are 72 countries/regions of the world which have contributed to research publications on Astaxanthin which indicates that there is a global network of a research groups focused on Astaxanthin. This study might be useful for researchers, students, and information seekers on Astaxanthin to find out the trends of research as a ready reference source.

### References

- 1 Pathak, M & Prasanna NK, A Bibliometric Analysis of Quassinoids Research - A Class of Bioactive Compounds. *J Sci Ind Res*, 79 (2020) 1017.
- 2 Fan KW & Chen F, Production of High-Value Products by Marine Microalgae Thraustochytrids, Shang-Tian Yang(Eds), Bioprocessing for Value-Added Products from Renewable Resources. *Elsevier*, (2007) 293.
- 3 Zhang G, Xie S & Yuh-Shan H, A bibliometric analysis of world volatile organic compounds research trends. *Scientometrics*, 83 (2010) 477.
- 4 Jian D & Tang XL, Natural products against cancer: A comprehensive bibliometric

- study of the research projects, publications, patents and drugs. *J Cancer Res Ther*, 10 (2014) 27. 5
- Pathak M & NK Prasanna, Pharmaceutical research in India: A scientometric analysis of international collaboration. *J Sci Ind Res*, 78 (2019) 738.