

*Original Research*

# **Bibliometric Overview of Research on Taste and Odor in Drinking Water during the 1980-2022**

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## **Abstract**

Due to the global climate change, water resources have been withdrawn and the pollutant loads have become concentrated, thus causing the taste and odor components of the waters to be felt globally, leading to an increase in research in this area. The goal of this study was to analyze the trends in research from 1980 to 2022 that concentrated on both the formation and removal of taste and odor components in surface water resources throughout the world. 965 papers were examined a systematic review and bibliometric analysis. The findings revealed a growth in research on taste and odor compounds as well as the popularity and applicability of novel purification techniques in addition to more traditional ways for removing these substances. Water Research was the journal with the highest impact in this area. The United States, China, Canada, Australia, and South Korea were the top 5 most productive nations. Studies on the speciation of taste and odor components are in the minority but demands for innovative treatment techniques such as advanced oxidation processes have been considered, and these compounds are an area of research with significant potential. This study can assist research with its worldwide findings on taste and odor compounds.

**Keywords:** bibliometric analysis, drinking water, SCI-expanded, taste and odor

## **Introduction**

Global warming causes rising temperatures and less rainfall in freshwater supplies, which increases the growth of algae and other organisms found in freshwater supplies [1]. Algae, especially blue-green algae, can produce 2-methylisoborneol (2-MIB), giving the water a bad taste and odor (T&O) [2]. Thus, the temperature rise in water supplies of global warming

may increase the production of 2-MIB and other compounds [3]. Eutrophication occurs when an excess of nutrients (especially nitrogen and phosphorus) enters water supplies [4]. Overgrowth of algae and blue-green algae can increase the production of compounds such as 2-MIB and trans-1, 10-dimethyl-trans-9-decalol (geosmin) [5]. These two chemical compounds cause the formation of T&O that can be perceived by humans at very low concentrations in the range of 4-10 ng/L [6]. These compounds can reach concentrations of 1000 ng/L in water sources during algal blooms [7]. In China and Japan, 2-MIB and geosmin are limited by regulations to the highest 10 ng/L in water resources, and in South

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Korea to 20 ng/L [8]. This can lead to a decrease in the T&O quality of water and is an important factor in the management of water resources.

Removing two chemicals is very difficult for all drinking water treatment plants worldwide [9]. 2-MIB and geosmin cannot be effectively removed by conventional treatment processes (coagulation, flocculation, and sedimentation) [10]. While conventional treatment processes are relatively successful in removing all cyanobacterial cells, they are ineffective in removing dissolved metabolites [11]. Since conventional processes have not been successful, it is recommended to use new methods that can achieve maximum concentrations of 15 ng/L for 2-MIB and 4 ng/L for geosmin [12]. Disinfectants and oxidants such as chlorine, chlorine dioxide and permanganate are also ineffective in removing T&O compounds [13]. Photocatalysis, ultraviolet (UV), persulfate and ozone-based processes have been tested by many researchers in removing T&O components [14]. Treatment processes such as advanced oxidation processes (AOPs), adsorption and membrane filtration are generally preferred for T&O removal [15]. When compared to traditional treatment techniques, AOPs are a particularly intriguing treatment technology [16]. Compared to membrane technologies or adsorption, AOPs directly break down organic pollutants rather than transfer them from one phase to another [17]. Activated carbon adsorption is recognized as an effective method of removing micropollutants including natural organic matter and T&O compounds [18].

In this study, although it is found in very low concentrations in water sources and drinking water, it is focused on undesirable T&O problems in end consumers. The effects of the T&O problem on human health are not yet fully known by researchers. Just as there are researchers who defend the negative effects of the T&O problem on human health, there are also researchers that argue that it does not have an effect on health. The common argument of the researchers is that the T&O problem is global and cannot be eliminated by conventional methods. This study aimed to fill a gap by analyzing the dynamics of the research into T&O compounds and its removal strategies since 1980 on a worldwide scale. The results may prove interesting for researchers of T&O compounds by offering a global view of the dynamics of this line of research.

## Methodology

In this work, the bibliometric analysis was done using Web of Science database. The removing of T&O compounds, the creation and speciation of species, and surface water sources were some of the issues that were investigated. In this kind of search, a sample of a more general topic is first chosen, and the sample is subsequently subjected to increasingly focused searches until a particular topic is found. This process' primary goal is to assess a topic's applicability to a larger body

of knowledge. A search was first conducted with the [TITLE-ABS-KEY ("drinking water")] criteria to include all works on the topic of drinking water. The sample was created during the years of between 1980 and 2022. Non-original papers were left out of our sample since they go through laxer peer review procedures, are harder to find, and could include duplicate material. The total number of articles in the final sample was 102,041. In order to investigate T&O studies in water sources, a second search was conducted with the following parameters: [TOPIC ("drinking water") AND TOPIC ("odor") AND TOPIC ("taste")]. Before arriving at the final sample, other search phrases were evaluated. The same restrictions as the first search were used, and 965 articles were sampled. The following factors were picked to look at the research's characteristics: year of publication, journals, authors, institutions and countries of affiliation, and keywords. The first action to be conducted once the data was downloaded in txt format was cleaning the data. Following that, data were processed and analyzed. The program used was Excel (version 16.66.1). VOSviewer was used to create useful network maps and examine the relationships between keywords. Because it is often used and appropriate for this kind of task, VOSviewer was picked. Finally, future trends were predicted, and the evolution of research trends was examined through the study of keywords.

## Results and Discussion

### The Fate of Taste and Odor Research

The development of the key factors in T&O compound research globally from 1980 to 2022. An average of 50 papers have been published on this topic each year for the past 10 years, up from 1 in 1980. This pattern suggests that T&O compound research has become more important, with the highest number of publications published in 2021 as a result. It would be quite fascinating to compare the overall increase of papers on T&O compound to the total growth of articles across all disciplines, but sadly, the existing study design did not allow for the collection of these data. By 2022, there will be 200 authors in this subject, up from 3 in 1980. From 50 to >3,000 references, the number rose dramatically. Additionally, throughout this time, the number of journals increased from 1 in 1980 to an average of 40 during the previous ten years. The number of nations, which increased from one in 1980 to 30 in 2022, reflects the field's globalization. While in 1980 only two articles were cited on the T&O compounds, this number has increased to an average of 800 over the last 10 years. While an average of 2 citations was made for each article in 1980, the average number of citations per article increased to 24.28 in 2022.

The development of the main categories under which articles on T&O compound are categorized by Web of Science. Keep in mind that a single article could be

listed under many categories at once. 25% of published publications during the study period were categorized as Environmental Sciences, 22% as Water Resources, 17% as Engineering Environmental, 5% as Engineering Civil, and 3% as Engineering Chemical. The categories of Materials Science, Medicine, Social Sciences, Public Environmental Occupational Health, Chemistry Analytical, Food Science Technology, and Marine Freshwater Biology were listed after them, however none of them accounted for more than 2% of the total number of publications. Environmental Science, Engineering Environmental, and Water Resources have been the main categories since the start of the studied period.

The ten most productive journals for T&O compounds articles are shown in Table 1. European journals, mainly British and Dutch publications, make up the entirety of this group. The fact that all the articles in the subject are published in these journals suggests that there isn't a lot of publishing in this discipline. The total number of articles published by each journal during the time is shown in the first column. From 1980 to 2022, Water Research produced the most publications on this topic (107 articles), followed by Water Science and Technology (79 articles), Journal of Water Supply Research and Technology Aqua (35 articles), and Science of the Total Environment (27 articles). Water Research reestablished itself in top place over the sub-period of 1980–2022. However, if the publications were added together, this journal would take first place with 107 articles and a total of 5274 citations. The journal with the most citations was Water Research, which was then followed by Environmental Science Technology, Water Science and Technology and Chemosphere. With a total of 74.62 citations per article, Environmental Science and Technology had the most effective when considering the average number of citations per article. Water Research

came in third with 49.28 citations per paper, followed by Chemosphere in second place with 51.04 citations per article. Notably, the top 10 journals all rank in the top three quartiles of the enlarged categorization of the scientific citation index, indicating that they are of the highest caliber.

The key traits of the universities that have produced the most papers on T&O compounds. The remaining ones were discovered in the United States, Canada, Taiwan, and Switzerland, with China accounting for about half of them. Chinese Academy of Sciences in China published the most publications, followed by Virginia Polytechnic Institute State University, Research Center for Eco Environmental Sciences, University of Chinese Academy of Sciences, and University of California System. The most referenced papers were produced by Swiss Federal Institutes of Technology (Switzerland), then by the Chinese Academy of Sciences, the University of California System, and Environment Climate Change Canada. In terms of the average number of citations per article, Swiss Federal Institutes of Technology came out on top with 83.3, followed by Environment and Climate Change Canada in Canada with 38.0, the University of California System in California with 33.9, and National Cheng Kung University in Taiwan with 31.0.

With 30 publications published since 2007, Jianwei Yu from the Chinese Academy of Sciences was the most active author among the authors. With a total of 19,493 citations and the highest H index (93), Urs von Gunten of the Swiss Federal Institute of Technology was the most frequently referenced author. Chunmiao Wang of the Chinese Academy of Sciences was the most recent author to join the group, and his first publication was released in 2019. With a total of 1,499.5 citations, Urs von Gunten had the highest average number of citations per article.

Table 1. Top 10 most productive journals for T&O research.

Journal	A	SJR	H Index	C	TC	TC/A	1st A
Water Research	107	2.806 (Q1)	327	United Kingdom	5274	49.28	1992
Water Science and Technology	79	0.447 (Q2)	145	United Kingdom	1177	11.89	1983
Journal of Water Supply Research and Technology Aqua	35	0.495 (Q2)	53	United Kingdom	425	12.14	1995
Science of the Total Environment	27	1.806 (Q1)	275	Netherlands	609	22.55	1991
Journal American Water Works Association	25	0.367 (Q3)	76	United States	671	26.84	1985
Water Science and Technology Water Supply	23	0.343 (Q3)	42	United Kingdom	197	8.56	2002
Chemosphere	21	1.505 (Q1)	265	United Kingdom	1072	51.04	2007
Desalination and Water Treatment	21	0.240 (Q3)	67	United States	183	8.71	2010
Environmental Science Technology	16	2.635 (Q1)	425	United States	1194	74.62	1997
Ozone Science Engineering	15	0.502 (Q2)	53	United Kingdom	431	28.73	1991

A: annual number of total articles; SJR: Scopus Journal Ranking; C: country; TC: annual number of citations for all articles; TC/A: number of citations by article; 1<sup>st</sup> A: first article of T&O research by journal



These methods are considered as environmental and futuristic approaches for the removal of T&O components and provide an environmentally friendly, sustainable, and effective water treatment process.

### Conclusion

This study examined the trends in T&O compounds research throughout the world between 1980 and 2022. A sample of 965 articles underwent a comprehensive and bibliometric examination. The findings revealed that the number of articles produced annually increase quickly, rising by 68% between 1994 and 1995 and 63% between 2006 and 2007. It might be claimed that significant turning moments for T&O components occurred in 1995 and 2007. The number of T&O compounds articles and journals, authors, institutions, and countries increased, indicating significant global interest in this area of study. This is because to several things, such as worries about global warming, a lack of water, and new, stricter laws in industrialized nations.

The journal with the most T&O compound papers was *Water Research*. The United States, Canada, Taiwan, Switzerland, and China were the next five countries with the highest number of publications published on T&O compounds. Additionally, these are the nations that publish the most articles on handling T&O compounds. Switzerland, Canada, the United States, and Taiwan are the top four countries when you take the average number of citations per paper on T&O compounds into account. Switzerland came out on top when population was considered.

When the keywords used in the papers under study were analyzed, it became clear that certain T&O compounds were among the most often used words. These included the phrases "Drinking Water," "Geosmin," "Cyanobacteria," "2-Methylisoborneol," "Taste and Odor," "Odor," "Water Treatment," "Water Quality," "Taste," and "Ozone". Main keywords' co-occurrence network in T&O research is shown in Fig. 1. Six distinct clusters centered on drinking water, cyanobacteria, water treatment, water quality, taste, and odor, as well as 2-MIB and geosmin were identified by the network mapping of the co-occurrence of terms.

### Conflict of Interest

The authors declare no conflict of interest.

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