Section A-Research paper

ARSENIC LEVELS PRESENT IN WATER INTENDED FOR HUMAN CONSUMPTION

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Abstract

To develop this article, a documentary review of the elaboration and production of research works related to the study of Arsenic Level and Water for Human Consumption was carried out to know, through a bibliometric study, the main characteristics of 336 publications registered in the Scopus database, during the period 2017-2021 at a global level. The data provided by this database were organized in graphs and figures, categorizing the information by variables such as Year of Publication, Country of Origin and Area of Knowledge, which allowed to identify, through qualitative analysis, the position of different authors about the proposed topic.

The main findings of this research were that the United States stood out as the country with the highest scientific production, leading the list with 53 publications. Likewise, the Area of Knowledge that contributed the most to the construction of bibliographic material related to the study of Arsenic Levels in Water and Water for Human Consumption was Environmental Science, with 229 published documents.

Keywords: Arsenic Level in Water, Humans, Drinking Water, Concentration, Toxicity, Living Beings**.**

1. Introduction

Much is said and heard about the daily deterioration of the environment due to the abuse of industrialization and bad practices in the treatment of natural resources. One of the most important resources is water, which is indispensable for the preservation and good development of species. Historically, several studies have been conducted to identify the best way to maintain the properties that characterize it and remain free of contamination.

By contamination, we refer to substances that alter the initial composition of the precious liquid and that, in high concentrations, would generate a level of toxicity, preventing its consumption and use. Such is the case of arsenic, which according to the Dictionary of the Royal Academy of the Spanish Language, can be defined as follows:

The chemical element of Atomic No. 33 is toxic and rare in the earth's crust, where it is found natively or combined with sulfur. 33, toxic, scarce in the earth's crust, where it is found native or combined with sulfur, used in electronics and the glass industry, as well as in the manufacture of pesticides and germicides. (Symb. As). (Arsenic. n.d. Retrieved from https://dle.rae.es/ars%C3%A9nico

This element, in particular, should be monitored since it is known to cause irreparable damage to human and animal health. For this reason, this article seeks to describe the main characteristics of the set of publications ascribed to the Scopus database and directly related to the variables Arsenic Levels in Water and Water for Human Consumption, as well as the description of the position of certain authors affiliated to institutions around the world, during the period between the years 2017 and 2021.

2. General Objective

To analyze from a bibliometric and bibliographic perspective, the development of research papers on the variables Arsenic Levels in Water and Water for Human Consumption registered in Scopus during 2017-2021.

3. Methodology

This article is conducted through a mixed research approach combining quantitative and qualitative methods.

On the one hand, a quantitative analysis of the information selected in Scopus is carried out under a bibliometric approach of the scientific production corresponding to the study of Arsenic Levels in Water and Water for Human Consumption.

On the other hand, from a qualitative perspective, examples of some research works published in the area of the study mentioned above are analyzed from a bibliographic approach that allows describing the position of different authors on the proposed topic.

It is important to note that the entire search was conducted through Scopus, establishing the parameters referenced in *Figure 1*.

3.1 Methodological design

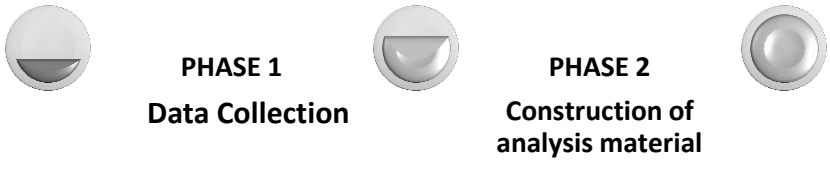

Figure 1. *Methodological design*
Source: Own elaboration

3.1.1 Phase 1: Data Collection

The data collection was executed from the Search tool on the Scopus web page, where 336 publications were obtained from the choice of the following filters:

TITLE-ABS-KEY (arsenic AND level AND in AND water AND for AND human AND consumption) AND (LIMIT-TO (PUBYEAR , 2021) OR LIMIT-TO (PUBYEAR , 2020) OR LIMIT-TO (PUBYEAR , 2019) OR LIMIT-TO (PUBYEAR , 2018) OR LIMIT-TO (PUBYEAR , 2017)))

- Published documents whose study variables are related to the study of Arsenic Levels in Water and Water for Human Consumption.
- Publications between the years 2017- 2021.
- Without distinction of countries.
- Without distinction of area of knowledge.
- Without distinction of type of publication.

3.1.2 Phase 2: Construction of analysis material

The information collected in Scopus during the previous phase is organized and subsequently classified through graphs, figures and tables as follows:

- Word Co-occurrence.

- ❖ Year of publication
- ❖ Country of origin of the publication.
- ❖ Knowledge area.
- ❖ Type of Publication

3.1.3 Phase 3: Drafting conclusions and final document

In this phase, the results previously obtained are analyzed, resulting in the determination of conclusions and, consequently, the final document.

4. Results

4.1 Co-occurrence of words

Figure 2 shows the Co-occurrence of keywords found in the publications identified in the Scopus database.

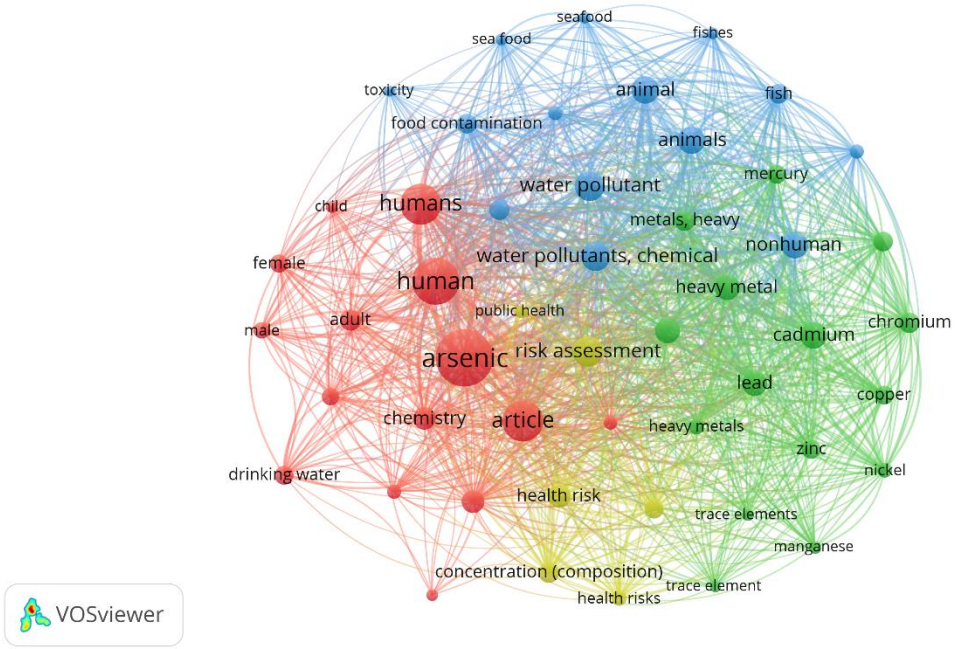

Figure 2. *Co-occurrence of words*

Source: Own elaboration (2022); based on data exported from Scopus.

As mentioned above, the data in Figure 2 come from the Scopus database, which shows our variables and their relationship with other terms such as Water Pollutants, Seafood, Heavy Metals, and Risk Assessment, among others that we will analyze below.

On the one hand, we can determine that those most affected by the levels of arsenic found in water are humans, who are at high risk of presenting health problems through the

consumption of contaminated water or the ingestion of food from the sea, such as fish and shellfish.

On the other hand, we find that water, in general, can modify its composition and be considered contaminated when it contains high levels of chemicals or heavy metals such as mercury, chromium, cadmium, zinc, and copper, to mention a few, which can produce adverse effects on human health and environmental conservation.

4.2 Distribution of scientific production by year of publication.

Figure 3 shows how the scientific production is distributed according to the year of publication from 2017 to 2021.

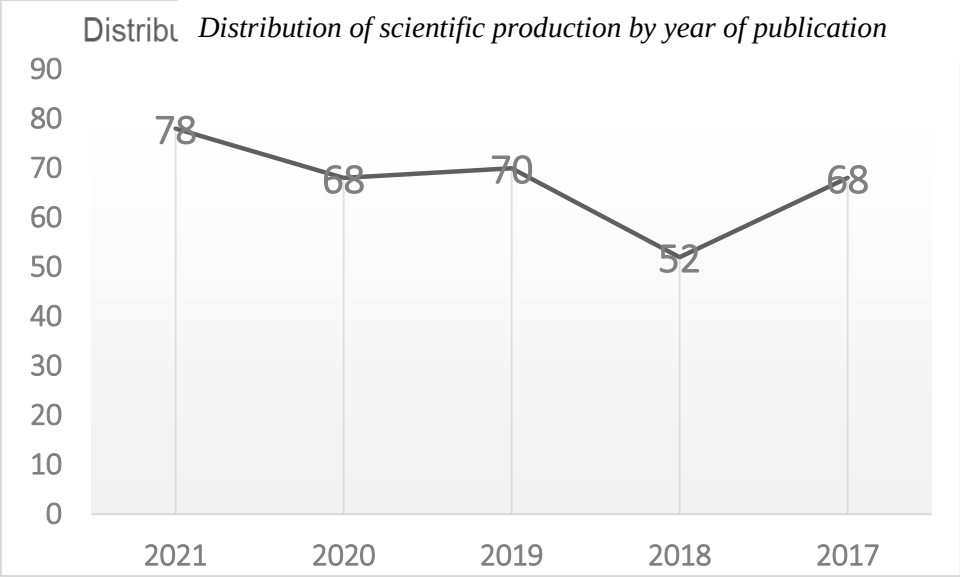

Figure 3. Distribution of scientific production by year of publication.
Source: Own elaboration (2022); based on data provided by Scopus.

Figure 3 shows the scientific production concerning the variables Arsenic Levels in Water and Water for Human Consumption between the years 2017 and 2021, left as a result of the publication of 336 documents containing the keywords. Likewise, it is observed that the following changes were experienced throughout the period. In 2017, there was a decrease in the number of documents related to Solid Waste from 68 publications to 52 in the following year. However, that number increased again in 2019, reaching 70 published documents. During 2020, the number decreased to 68 publications per year, which changed in 2021, culminating with 78 publications. Of these last publications, the article entitled "Arsenic contamination of groundwater: a global synopsis with a focus on the Indian Peninsula" (E, et al., 2021) determined that until the year 2021, 108 countries in the world

were consuming water with high levels of arsenic as a result of various transformations or changes experienced by the earth such as "processes of plate tectonics, mountain formation, erosion and sedimentation," causing serious effects on humanity and its health. Although there are measures to remove arsenic from water, the authors emphasize the need to educate and promote the population about this problem that involves the whole world.

4.3 Distribution of scientific production by country of origin.

Figure 4 shows the distribution of scientific production according to the nationality of the authors

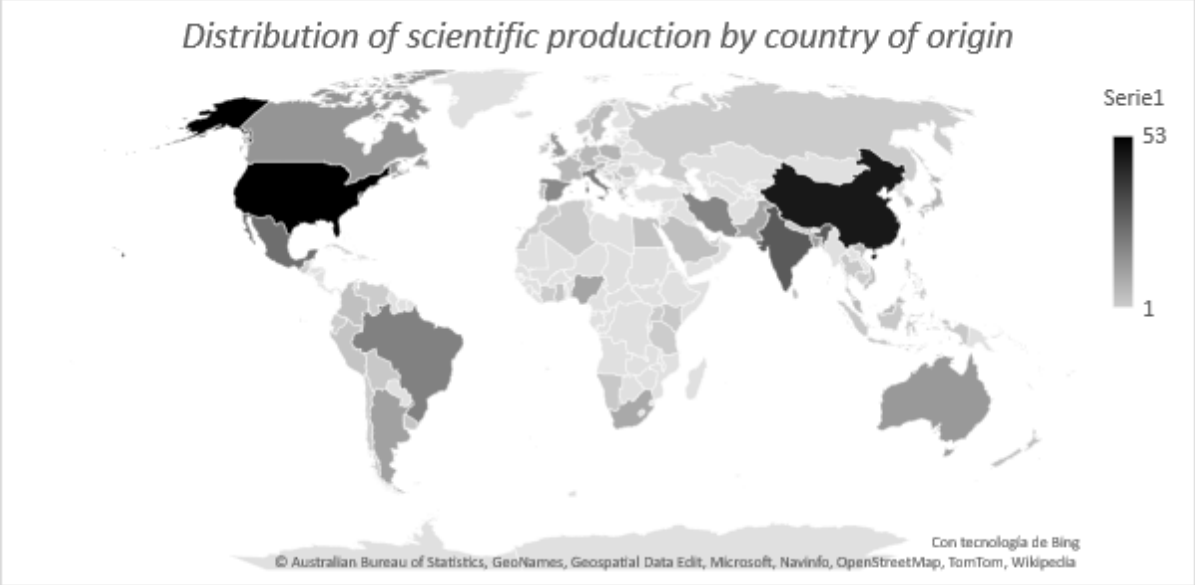

Figure 4. *Distribution of scientific production by country of origin.*
Source: Own elaboration (2022); based on data provided by Scopus.

In the study of Arsenic Levels in Water and Water for Human Consumption, the United States leads the list of published articles with a total of 53 records in the Scopus database during the period 2017-2021, followed by China and India with 47 and 30 publications, respectively. A case in point is the article "Inorganic contaminants in the water of Midland and Odessa, Permian Basin, West Texas" (Rodriguez et al., 2019), where a study is carried out to measure the levels of contamination in the water of these two cities, taking into account that each receives the liquid from a different aquifer, concluding that, although one is more contaminated than the other, both are acceptable for consumption and obtain these contaminants "partially or mainly from human activities." (Rodriguez et al., 2019).

At this point, it is important to note that scientific publications are often prepared based on collaborations involving private and public institutions from one or more countries. Therefore, the same publication may be linked to one or more authors with different nationalities, as well as to more than one country simultaneously, making part of the total sum of articles or publications of each of them in the final sum. *Figure 5* below shows in greater detail the flow of collaborative work carried out by several countries.

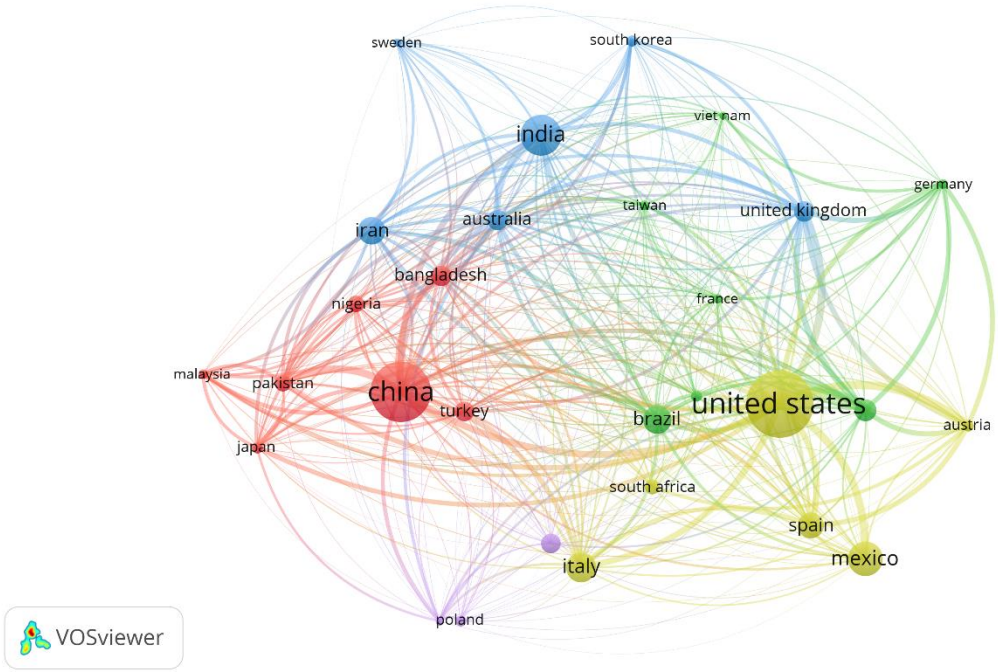

Figure 5. *Co-citations between countries.*
Source: Own elaboration (2022); based on data provided by Scopus.

Figure 5 shows the research grouping according to the development of collaboration between authors from other international institutions. There is an outstanding participation of authors affiliated with institutions in countries such as the United States, China, India, Brazil, United Kingdom, Spain, and Japan, among others.

4.4 Distribution of scientific production by area of knowledge

Figure 6 shows the distribution of the production of scientific publications according to the area of knowledge through which the different research methodologies are implemented.

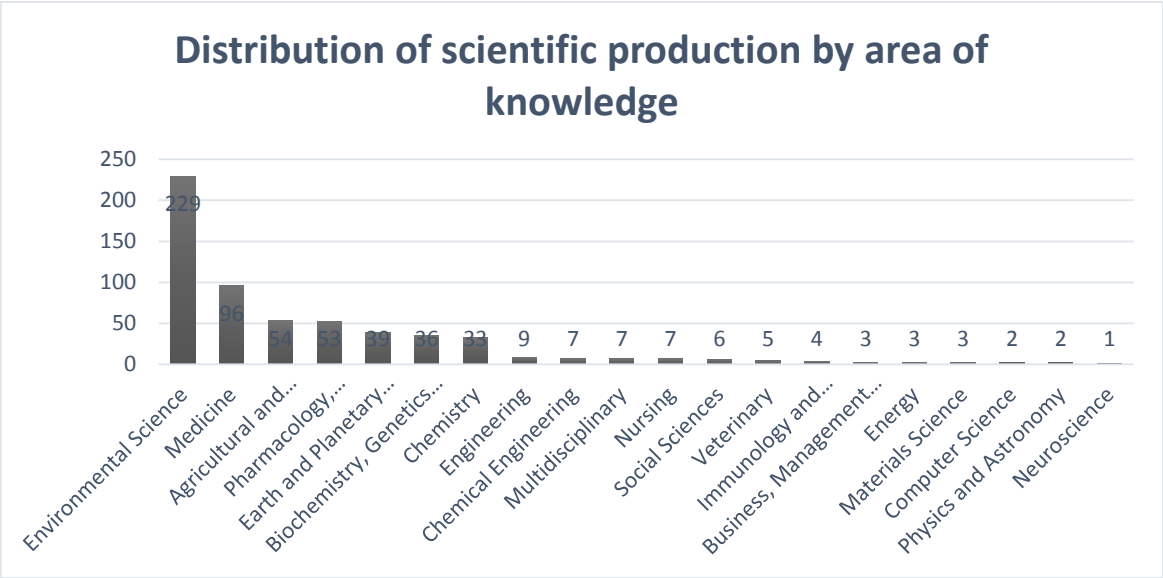

Figure 6. Distribution of scientific production by area of knowledge.
Source: Own elaboration based on the data from Scopus.

Due to the importance of water quality in conserving the environment, Environmental Science is the area in which most papers related to Arsenic Levels present in Water for Human Consumption are carried out and subsequently published in the Scopus database. Also other areas such as Medicine, Agriculture and Biological Sciences have been of great help for the study of such variables between 2017 and 2021, managing to publish 96, 54 and 53 documents, respectively.

As shown in *Figure 6*, the variables that are the subject of this study are of great importance for all areas of knowledge since they directly impact living beings, their well-being and, therefore the prolongation of the species.

4.5 Type of publication

The following graph shows the distribution of the bibliographic findings according to the type of publication made by each of the authors found in Scopus.

Figure 7. *Type of publication*

Source*: Own elaboration based on the data from Scopus*

Figure 7 explicitly shows that the predominant type of publication in the study of Arsenic Levels in Water and Water for Human Consumption during the years 2017-2021 was the Journal Article with a total of 308 documents. This is equivalent to 91.7% of the total number of publications found.

In second place are reviews, with 3.6%, followed by conference papers, with 2.7%. Among the 12 reviews, we find titles focused on managing and treating water from Rivers or other sources that affect the ecosystem in a general way. As does the following title "Microbial biotechnology as an emerging industrial wastewater treatment process for arsenic mitigation. A critical review" (Hayat et al., 2017) suggests the use of microbial remediation to treat industrial wastewater contaminated with arsenic to avoid resorting to conventional mechanisms that "face limitations in the form of lack of technical experience and low effectiveness" (Hayat et al., 2017). In their study, the authors state that this new alternative could be considered a "respectful solution", without the production of solid/liquid waste", as it achieves the dilution of the substance harmful to health and in turn decreases the investment in waste management.

5. SAMPLING AND ANALYSIS OF SAMPLES CARRIED OUT THROUGH THE RESEARCH PROJECT FOR DETERMINATION OF ARSENIC AND BORON IN LOCUMBA RIVER BASIN DURING JULY 2022:

As part of the Research Project entitled "Analysis and Modulation of Modern Water Technologies for the removal of Arsenic and Boron in the basins of the Tacna Region" -

Jorge Basadre Grohmann National University, Tacna, Peru; The following experiment was performed:

5. 1 METHODOLOGY

Methodology for Sampling

a) Identify the sampling site and prepare equipment and implements.
b) Put on the monitoring implements: apron and gloves.
c) Measure physicochemical field parameters such as temperature, pH, conductivity and temperature with the respective equipment; and proceed to record the results.

d) Collect the required samples and proceed to fill the bottles, according to the parameter to be analyzed, adding the necessary persevants and closing with countercaps and lids.
e) Complete the labeling of each bottle indicating:
- Sample code
- Type of sample
- Date and time
- Preservation performed

f) Store the bottles in the cooler with refrigerant for transfer to the laboratory.
g) Fill out the chain of custody, with which the samples will be entered into the laboratory.
h) Finally, transfer the samples to the laboratory for analysis.

Analysis Methodology

The method used for total metals is EPA Method 200.8 Rev. 5.4 (1994), the technique used is Espect. ICP-MS.

Monitoring Materials (Sampling)

- Gloves.
- Labeled plastic bottles.
- Tapas and back covers.
- Preservante. (HNO_3)
- Distilled water.

- Cooler.
- Chain of custody.
- Field notebook and pen.

5. 2 MONITORING STATION

Locumba Basin

Location:

It is located between the geographical coordinates 70°06‟ and 71°05‟ West longitude and 16°47‟ and 17°54‟ South Latitude. Politically, it is located in the departments of Tacna and Moquegua, occupies part of the provinces of Tacna, Tarata, Jorge Basadre, Candarave, Mariscal Nieto and General Sánchez Cerro. The limits of the basin are: on the north the dividing of the basins of the Chilota and Vizcachas rivers, on the south Pacific Ocean, on the east basin of the Sama river and on the west basin of the Moquegua river.

Hydrography:

The hydrographic network of the Locumba River is controlled on the Curibaya and Ilabaya rivers by the Ticapampa and Cairo gauging stations, respectively. These stations measure the discharges of the collecting basins, whose approximate extensions are, 225 km2 in the Curibaya River and 955 km 2 in the Ilabaya River.

Temperature

The average temperature in the zone of 0 m.a.s.l. to 1 000 m.a.s.l., reaches a maximum value of approximately 21°C (January - March) and a minimum value of approximately 15°C (June - August). The values of the maximum temperature were, 26 ° C in the coastal zone and 14 ° C in the high zone. The values of the minimum temperature were, 13 ° C in the coastal zone and -10 ° C in the high zone.

Water sources

The main water sources of the upper basin of the Locumba River that drains into the Aricota Lagoon have a flow measurement network that allows monitoring their water supply in all its amplitude. The main hydrometric control stations are:

Kovire-Túnel (Río Ancoaque), KovireBofedal (Río Ancoaque), Talacaya (Río Tacalaya) and Aricota (Entrance to Laguna Aricota: Ríos Callazas and Salado).

5.3 SAMPLING

Sampling points

Locumba Basin

The samples were taken in the Locumba Basin specifically in the **District of Ite**, during the month of July 2022, identified with the following sampling codes:

SAMPLE CODE	**COORDINATES**		
	NORTH	**THIS**	**ALTITUDE**
P1	8028769.00 m S	295732.00 m E	219
P2	8027874.00 m S	295423.00 m E	154
P3	8026811.00 m S	294891.00 m E	143
P4	8025809.00 m S	294500.00 m E	179
P5	8024132.00 m S	290536.00 m E	148
P6	8023927.00 m S	293880.00 m E	163

5.4 WATER SAMPLE ANALYSIS RESULTS

On-site parameters

SAMPLE	**Parameters**		
	pH	**Conductivity µS/cm**	**Temperature Cº**
P1	8.40	2259	18.1
P2	8.42	2232	17.8
P3	8.45	2227	17.0
P4	8.40	2256	17.1
P5	8.36	2226	17.0

P6	8.41	2228	17.1

Laboratory Results

SAMPLE	**Parameter**	**Result**	**Units**
P1	Total Arsenic	0,48265	mg/L
	Boro Total	8,49	mg/L
P2	Total Arsenic	0,48325	mg/L
	Boro Total	8,77	mg/L
P3	Total Arsenic	0,48692	mg/L
	Boro Total	8,63	mg/L
P4	Total Arsenic	0,48287	mg/L
	Boro Total	8,82	mg/L
P5	Total Arsenic	0,48536	mg/L
	Boro Total	9,01	mg/L
P6	Total Arsenic	0,49229	mg/L
	Boro Total	9,10	mg/L

6. Conclusions

Finally, thanks to the bibliometric analysis carried out in this research work, it was possible to establish that the United States was the country with the highest number of published records regarding the variables Arsenic Levels in Water and Water for Human Consumption with a total of 53 publications in the Scopus database during the period 2017-2021.

It is also possible to determine that the levels of arsenic present in water for human consumption depend on the country chosen for the study. Although some regions maintain an acceptable level of arsenic, most of them have not been able to guarantee their population access to 100% potable water. That is why the object of study of their research lies in the adverse effects produced by the ingestion of arsenic through food products and drinking water.

For this reason, it is urgently required that countries and international organizations work together to promote environmental education that allows better management of resources and, therefore, decreases in their contamination. Incentive programs, company bonuses or

tax reductions for companies that generate contaminated waste could be some alternatives to initiate this process.

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