

# Bibliometric Study of Obtaining Furfural and Hydroxymethyl Furfural from Sugarcane Bagasse

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## Abstract

This electronic document is a bibliometric observational study describing the production of furfural and hydroxymethylfurfural from sugarcane bagasse during 2015-2021; were used as main measures, magazine, year of publication, first/last author, workplace, and autonomous community as the primary measures. Subsequently, articles were classified according to their content or research area. The impact factor was obtained from the Scopus and Vos Viewer bibliometric analysis. The results are presented in various figures. Through the search criteria used, 639 documents were retrieved in the 2015 -2021 six- year term, excluding 307 because they did not correspond to affiliation with centers or institutions directly related to papers related to furfural and hydroxymethylfurfural. A total of 49 documents were selected, and an increase in interest in studying these compounds was verified in the research and the journals in which they were published. Most studies have been published in universities or research centers, and differences were observed in the volume of international and national scientific production, making it necessary to increase these investigations in Colombia.

**Keywords:** Sugarcane bagasse • Bibliometric • Seizure • Furfural • Biofuel • Biomass

## Introduction

Furfural and hydroxymethylfurfural are products that emerge from the decomposition of monosaccharides found in sugarcane's bagasse; said decomposition can begin when the concentrations of sugar and acid are adequate [1]. The sugars in sugarcane can be used as a carbon source; however, the main limitation to biomass taking is the availability of fermentable compounds [2]. Most of the glucose in lignocellulose is found within crystalline cellulose polymers, while hemicellulose also contains them, but in the form of copolymers composed of glucose, xylose, and others [3]. Only through scientific publications do research results transcend the author's limits and can be shared by the scientific community [4]. Although research aims to contribute to the advancement of knowledge, publication constitutes an essential phase since it allows the dissemination of new knowledge and contributes decisively to scientific progress. Publication analysis is the most common way of evaluating scientific productivity since bibliometric indicators have the advantage of being objective and serving to complement the judgment of experts [5]. However, despite their usefulness and absolute value, it is necessary to analyze bibliographic citations that present limitations when used as the only mechanism for evaluating scientific activity. In the biotechnology area, publishing articles is not synonymous with making scientific contributions; even if these are journals with a high bibliographic impact factor, it does not necessarily imply that the pieces will have a significant impact on biotechnology and the agricultural industry [6].

Regarding the result of research, this can be defined as the extent to which new knowledge contributes to improving clinical practice, the behavior of professionals, and the social impact on the population [7].

Currently, in Colombia, the productivity and impact of furfural and hydroxymethylfurfural research continue to be low, pointing to a significant gap between the academic world and biotechnology, as well as shortcomings in terms of organization of research activities and provision of resources necessary [8].

Bibliometric culture has evolved in the country, and various studies have analyzed the investigation of compounds used in the biotechnological process [9]. However, their results are hardly comparable, given that their methodology has been highly variable due to the diversity in the sources of information consulted and the search methods used [1]. While only some of these studies address the description of international scientific production, others refer to more limited geographical areas, specific aspects such as the use of organic industrial waste, solid or liquid, or focus on particular journals.

On the other hand, although scientific publications on biotechnology in Colombia focus on the use of organic waste to reduce environmental impact, the rest of the scientific production is distributed in a great diversity of journals of numerous specialties, and together with the lack of updating This type of study and the use of standardized and reliable methods make it difficult to retrieve the research results. Despite these limitations, bibliometric studies on obtaining furfural and hydroxymethyl furfural compounds from sugarcane bagasse provide beneficial formation for professional activity and research [10].

Evaluating other aspects such as the volume of research activity, its evolution over time, the type of research, the topics addressed the most active groups and centers in the different areas, and the collaborations between them. For this reason, this research aims to determine the scientific production of obtaining furfural and hydroxymethyl furfural from sugarcane bagasse, analyzing its geographic distribution, the impact factor of the journals involved, and the main research areas and the participation of the different institutional sectors [11].

## Materials and Methods

This study is an observational study of a bibliometric nature and international scope whose time frame has been the period 2015-2021. The units of analysis were the scientific articles directly related to the compounds of furfural and hydroxymethylfurfural from sugarcane bagasse, published in any periodical scientific journal indexed in the Scopus database, performing a generic search strategy free retrieving even most significant rest a possible number of references published in each autonomous community during the study period [10].

For this, the following search criteria were used: "Name of the compound (s) (furfural and hydroxymethyl furfural)," "bagasse," "cane," and "sugar.". Each recovered document was manually reviewed, excluding those that did not correspond to furfural and hydroxymethylfurfural, based on the information contained in the title, abstract, and membership data.

The following variables were collected in each of the records obtained: Journal-title year of publication, surnames, and initials of the first and last author, institution, or workplace of the first signatory and autonomous community. Subsequently, the articles were classified into the following sources; environmental technology, crops and industrial products, biotechnology for biofuels, sustainable DHW chemistry, and engineering, biomass conversion and bio refining dry, and industrial and engineering chemistry research [10,12,13]. In cases where more than one institution was mentioned, the article was assigned to the one that appeared first. The documents with few research coincidences were discarded, as illustrated in Figure 1.

## Results

Through the search criteria, 639 documents were recovered in the six years-2021, excluding 307 because they did not correspond to affiliation to centers or institutions directly related to records sed to furfural and

hydroxymethylfurfural. In total, 49 papers were selected, and ten different authors were identified, as indicated in Figure 2.

In Figure 3, the various percentages of the analysis of the documents by study area are indicated, in Chemical Engineering, 159 journals were found (20.1%), in Energy, 156 (19.7%), in Environmental Science, 138 (17.4%), in Chemistry 82 (10.4%), in Biochemistry, Genetics and Molecular Biology 56 (7.1%), in Engineering 49 (6.2%), in Agricultural and Biological Sciences 47 (5.9%), in Immunology and microbiology, and Materials Sciences 34 (4.3%), in Physics and astronomy 16 (2%) and other documents 20 (2.5%).

When analyzing the documents by year, between the period of 2015 and 2021, the first five years, there were a more significant number of publications, in 2017 and 2018, where 65 and 61 articles were disseminated, respectively, reaching the highest points. As of 2019, the number of publications began to decrease, but without minimizing their importance, since even by 2021, there are already four articles related to obtaining furfural and hydroxymethylfurfural, as shown in Figure 4.

Forty-eight studies related to Bioenvironmental Technology were identified between 2015 and 2020, being the most relevant research source. Only nine starts were found in Chemical, Industrial, and Engineering Research, as indicated in Figure 5.

When investigating the documents according to affiliation, it was determined that the country of China is where a more significant number of publications have been published, finding 47 investigations being the Ministry of Education of China, where they have carried out the most important number of studies. In the case of South America, 27 scientific journals disseminated in Brazil were identified; being in the State University of Campinas, where they have studied in greater depth, determining that studies related to obtaining furfural and hydroxymethylfurfural are little investigated (Figure 6). Considering that the country of China has a more significant number of studies, the most relevant authors are Doherty, Yuan, Qi, and Yu, as indicated in Figure 7. To complement this analysis, it was determined that China, Brazil, and the United States are the countries where this study is more relevant. Only eight publications exist in Australia between 2015 and 2021 (Figure 8).

Finally, the types of research carried out during the period of this bibliometric study were investigated, finding 291 articles (88%), 20 reviews (6%), 11 session documents (3.3%), eight book chapters (2.4%), and one retracted (0.3%) as indicated in Figure 9.

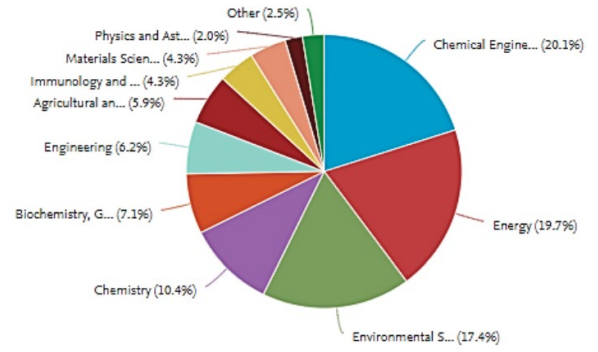


Figure 3 Documents by study area.

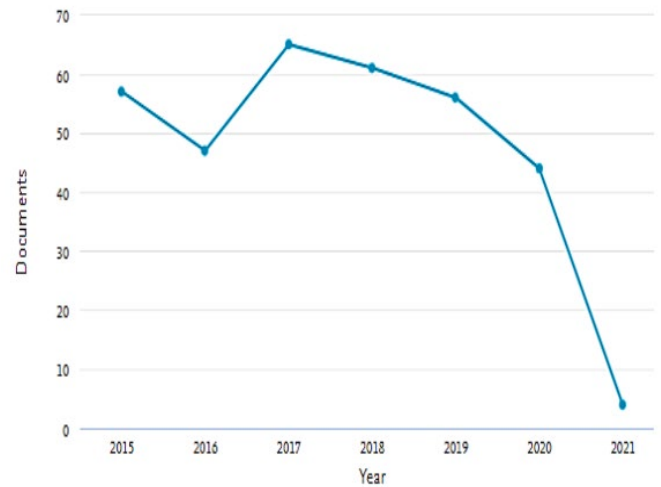


Figure 4. Documents by year of publication.

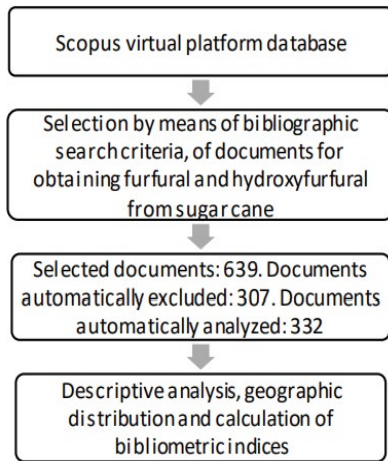


Figure 1. Study outline.

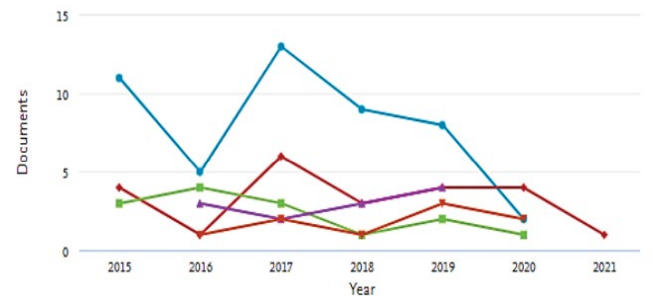


Figure 5. Documents by year and by source.

Note: ● Bioresource technology; ◆ Industrial crops and products; + Biotechnology for biofuels; ▲ ACS sustainable chemistry and engineering; ✦ Industrial and engineering chemistry research

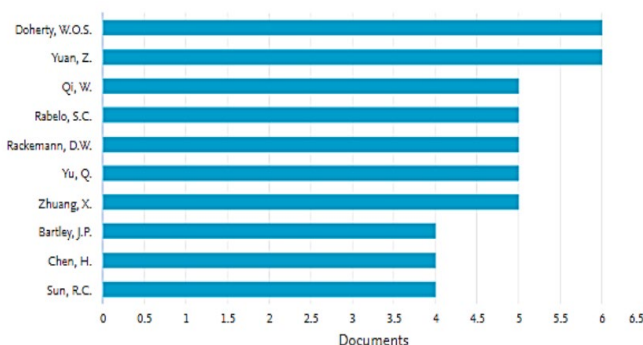


Figure 2. Documents by author.

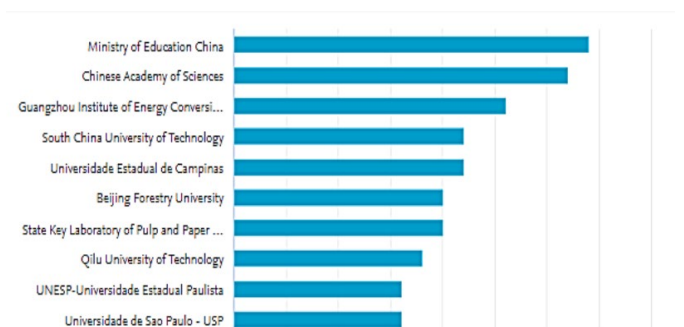


Figure 6. Documents by affiliation.





## Discussion

In the recent scientific production indexed in Scopus related to obtaining furfural and hydroxymethyl furfural from sugarcane bagasse, a wide variety of documents was observed, both by the research areas and by the journals where they are published, verifying that the majority of authors have published a single article in the last five years. The increase in production has been progressive in this period, and most of the work has originated in universities or research institutes, showing a growing trend in recent years. Despite the difficulty in classifying the articles' content, as in previous studies, a predominance of biotechnological studies is verified, especially in biofuel production from organic matter [16].

As for the most frequented journals related to the subject of study, the number of investigations has increased during the last five years, a great distance from other years. Altogether, most of the studies have been carried out in the Eastern continent, specifically in the country of China the country of Brazil is the leading exponent dedicated to obtaining these compounds from biomass, followed by the United States. Furthermore, the superiority of publications was observed when they were produced in research units or institutes, as well as their bibliographic impact factor. Some autonomous communities stand out for a more significant number of documents concerning the number of inhabitants, and there are also a higher proportion of articles published in magazines from other countries.

Although the scientific production of furfural and hydroxymethyl furfural, its relevance and impact have not reached the desired level in biotechnological research in recent years, research in this field has been adding recognition to its quality at the international level [3]. In general, obtaining furfural and hydroxymethyl furfural in Colombia is still an emerging discipline compared to other countries such as China, Brazil, and the United States, where research is more consolidated.

These aldehyde compounds offer great opportunities for obtaining alternative energies that do not harm the environment or produce paper from discarded organic matter [2,17]. The use of biotechnological procedures and the reuse of waste is currently highly studied because identical or equal compounds can be obtained that can partially or entirely replace the products obtained from petroleum [18].

At the moment, it is recognized that in Colombia, the need to develop research on these compounds and the low visibility of scientific production has been highlighted [10,12]. Networks and research institutes for furfural and hydroxymethylfurfural). The results also indicate a high rate of transience in the research, which suggests implementing strategies to consolidate lines and research groups [4]. It is possible that the creation of university departments of Biotechnology, as has happened in almost all Western countries, can also serve as a strategy to improve the volume and quality of research. To see if this happens in the coming years and to be able to quantify the magnitude of the changes, bibliometric studies will continue to be of the utmost utility.

## Conclusion

In conclusion, in the published documents related to obtaining furfural and hydroxymethyl furfural in recent years at an international level, an increase in interest in studying these compounds was verified both in the research areas and in the journals in which they are published. Most of the studies have been published in universities or research centers. Differences were observed in the volume of international and national scientific production, making it necessary to increase these investigations in Colombia.

### What is known about the subject?

- Scientific publications can disseminate new knowledge and make a decisive contribution to the development of cinema.
- Bibliometric studies related to the acquisition of furfural and hydroxymethyl furfural provide helpful information on professional activities and research carried out, including evaluating scientific production and its evolution over time.
- Publications of research topics are distributed to many professional journals, adding to the lack of updates in bibliometric research, making it challenging to evaluate scientific results.

### What does this study contribute?

- In recent years, the scientific production of furfural and hydroxymethyl furfural has increased. Dominating the publications is biotechnology

research for producing biofuels from organic waste.

- Some autonomous communities require more documents related to the number of residents, and the proportion of articles published in magazines from other countries is also higher.

## Conflict of Interest

The authors declare that they have no conflicts of interest.

## Acknowledgement

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