

# RESEARCH TREND ANALYSIS OF HIGH-VALUE PRODUCTS BY ANAEROBIC FERMENTATION BASED ON THE WEB OF SCIENCE DATABASE

Yuanchun Zhang<sup>1</sup>, Wenbin Zhu<sup>1</sup>, Na Song<sup>2</sup>, Ming Gao<sup>1</sup> and Qunhui Wang<sup>1</sup>

<sup>1</sup> School of Energy and Environmental Engineer, University of Science and Technology Beijing, 30 Xueyuan Road, Haidian District, Beijing 100083, China

<sup>2</sup> Tianjin College, University of Science and Technology Beijing, 1 Zhujiang North Ring East Road, Baodi District, Tianjin 301830, China

## INTRODUCTION

Organic solid waste (OSW) is a type of organic matter produced by human activities, about 2.01 billion tons of OSW are produced globally each year, and the yield of OSW has been on an upward trend due to the rapid development of modern society and the continuous growth of the global population [1]. OSW is rich in biodegradable organic matter (such as proteins, carbohydrates and lipids) and phytonutrients (nitrogen, phosphorus and potassium) that can be reused as inexpensive and readily available raw materials in green energy production [2]. Anaerobic fermentation (AF) is an efficient and economical method for the treatment of organic solids, from which a large number of renewable resources can be obtained. AF can achieve efficient organic solid waste treatment and contribute to the development of a low-carbon economy and the replacement of clean energy. The synthesis, preparation, processing and application of AF products have enormous potential for large-scale development, and their market demand is rapidly increasing. Because of differences in physical and chemical properties, as well as microbiological composition, the pretreatment process, fermentation process, and composition of fermentation products differ between organic solid wastes.

In this paper, a bibliometric method was used to study the research of anaerobic fermentation from 2001 to 2021, and different kinds of indicators were analyzed. We combined the results of the current study of anaerobic fermentation, and also can provide a guiding role for future development.

## MATERIALS AND METHODS

The ISI Web of Science and Science Citation Index Expanded (SCIE) database were the primary data source. The Web of Science of the Institute of Scientific Information is an internationally recognised major retrieval tool for scientific statistics and evaluation, and a major platform for exchanges between international scholars [3]. In this study, (anaerobic ferment\*) was used as a search phrase to search topics in SCIE for the

period from 2001 to 2021. Furthermore, the Web of Science offers intelligent tools for data analysis in various forms, making it possible to approximate the trend in the field of AF for a specific raw material/product by searching for the keyword 'anaerobic fermentation' combined with that raw material/product.

For the research on anaerobic fermentation, all the analysis were all count using Microsoft Excel 2016.

## RESULT AND DISCUSSION

2896 publications related to anaerobic fermentation from 2001 to 2021, research articles are the most important form of literature output, with a total of 2380 articles, accounting for about 82.2% of the total statistical literature.

### (1) Characteristics of publication outputs

The top five countries with the largest number of publications are China, the United States, Germany, India and Japan (Fig.1).

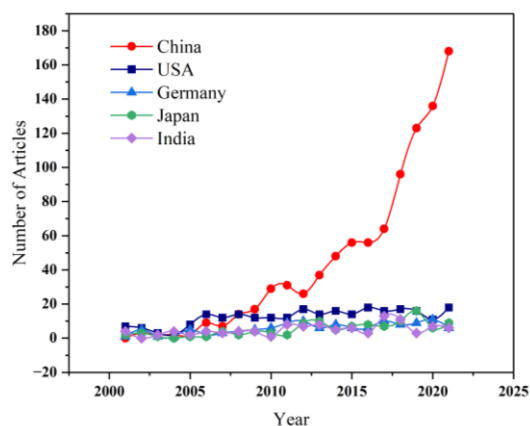


Figure 1. Published articles on AF related research from 2001 to 2021

After 2008, China ranked first in terms of the number of published documents than other countries, mainly because the Chinese government began to pay attention to the recycling of food waste. In addition, the number of countries/regions participating in AF research has increased from 32 in 2001 to 380 in 2021, which shows

that AF-related research has attracted worldwide attention, and the cooperation trend of various scientific research institutions has also significantly enhanced, the technology of using AF to treat solid waste has been widely used.

### (2) Distribution of journals and subject categories

According to the analysis of discipline categories in the Journal Citation Report based on ISI, the number of discipline categories exceeding 10% of the total number of articles is 6. Amongst them, Biotechnology & Applied Microbiology contributed the most with 803 articles, followed by Energy Fuels, Engineering, Environmental Sciences Ecology, Agriculture and Chemistry. Microbiology also ranked in the top eight, which is consistent with the fact that the AF process mainly relies on the action of microorganisms. In addition, AF products have been gradually applied in the energy field in recent years, and this technology has made significant contributions to the treatment of agricultural organic wastes, such as straw, weeds, fallen leaves, fruit shells, and etc.

### (3) Research hotspots in AF

By analysing the keywords of AF-related papers, we can understand the research trend information and identify research hotspots [4]. Amongst the top 30 keywords in the search frequency, there are fermentation substrates such as waste activated sludge; food waste; microalgae and crude glycerol; and fermentation products such as hydrogen, biogas, ethanol, butanol, VFAs, lactic acid and succinic acid, which also reflect the research hotspots in this field.

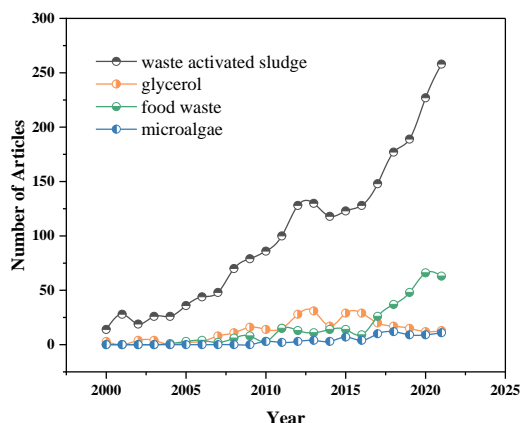


Figure 2. The trend of the relevant articles of different substrates over time from 2001 to 2021

The production of platform chemicals and fuels from renewable resources is a major focus of circular economy. Hot research products of AF include energy substances such as biohydrogen, biogas, bioethanol, and biobutanol, and liquid chemicals such as VFAs, succinic acid and lactic acid.

The analysis of keywords revealed that the valorisation of cheap and easily available raw materials with high organic matter content and the production of clean

energy substances and high value-added platform products will continue to become global research hotspots in future research.

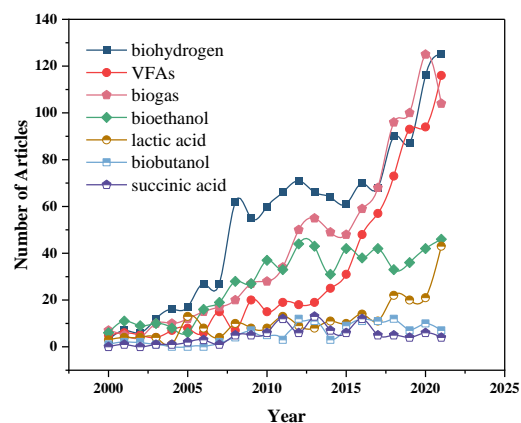


Figure 3. Growth trend of different AF products from 2001 to 2021

## CONCLUSION

Based on the articles in the SCI database, this study used bibliometrics to conduct a statistical analysis of the relevant articles on AF from 2001 to 2021. The analysis of keywords shows that biomass wastes with low price, easy availability and high organic matter content (such as waste activated sludge, food waste, microalgae and crude glycerol) have good potential for resource utilisation. The production of clean energy substances such as hydrogen, biogas, ethanol and butanol through AF will continue to be the focus of attention.

## ACKNOWLEDGEMENT

This work was supported by the National Key R&D Program of China (Grant NO. 2019YFC1906302 & 2019YFC1906304) and Tianjin Education Commission Scientific Research Planning Project (2021KJ064).

## REFERENCE

1. Wainaina S, Awasthi MK, Sarsaiya S, Chen H, Singh E, Kumar A, et al. Resource recovery and circular economy from organic solid waste using aerobic and anaerobic digestion technologies. *Bioresour Technol* 2020;301:122778.
2. Ma Y, Liu Y. Turning food waste to energy and resources towards a great environmental and economic sustainability: An innovative integrated biological approach. *Biotechnol Adv* 2019;37:107414.
3. Ho Y-S. The top-cited research works in the Science Citation Index Expanded. *Scim* 2012;94:1297-312.
4. Hou Q, Mao G, Zhao L, Du H, Zuo J. Mapping the scientific research on life cycle assessment: a bibliometric analysis. *The International Journal of Life Cycle Assessment* 2015;20:541-55.