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**Review Article**

# Global and Malaysian trends in biosensor development for food safety: A mini bibliometric analysis

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**Abstract**

Biosensors have gained significant attention in food safety due to their high sensitivity, selectivity, rapid response, and portability. Despite these advantages, bibliometric analysis on biosensors development for food safety remain limited, particularly in the context of Malaysia. This study employed the Scopus database and VOSviewer software to conduct mini bibliometric analysis. The analysis revealed prominent keywords, namely *limit of detection*, *food safety*, and *biosensing techniques*. A total of 10,385 English-language research articles published between 2020 and February 2025 were analysed. The results revealed a steady increase in publications, with China (5,556 articles), the United States (888 articles), and India (515 articles) leading global output. Most studies were published under the subject areas of *Chemistry*, *Agricultural and Biological Sciences* and *Biochemistry*, *Genetics and Molecular Biology*. Malaysia was ranked 25$^{th}$ globally and 2$^{nd}$ in Southeast Asia, with a contribution of 100 articles. These findings suggest Malaysia is poised to advance further in biosensor application for food safety, supported by growing publication output, strong collaborations and active local universities.

**Keywords:** Bibliometric analysis; biosensor; food safety; food contaminants

## Introduction

Food safety have become a global priority in safeguarding public health, attracting increasing attention in recent years. Harmful food contaminants, such as mycotoxins, bacteria, viruses, heavy metals, pesticides, and chemical additives, pose serious health risks to humans [1, 2]. Detecting these contaminants is therefore crucial to protecting community well-being [3]. Biosensor, analytical tool that employs biological recognition elements such as enzymes, DNA, or antibodies [4, 5] offer numerous advantages: high sensitivity and selectivity, simple design, minimal sample preparation, rapid response, and portability [6]. A typical biosensor comprises five components: analyte, bioreceptor, transducer, electronic systems, and display unit. Depending on the bioreceptor type, biosensors can be classified into enzymatic biosensors, immunosensors, aptamer/nucleic acid-based biosensors, and microbial or whole-cell biosensors [7]. Previous bibliometric studies on biosensor had largely focused on medical application, including eye diseases [8], health monitoring [9], and disease diagnosis [10]. In food safety, bibliometric reviews have examined foodborne pathogens [11] and food quality [12]. However, bibliometric analysis specifically addressing biosensor development for food safety, particularly from Malaysia's perspective remain scarce. This study was significant as it highlighted emerging research trends and potential collaborations in Malaysia. National policies such as the *National Biotechnology Policy 2.0*, *BioNexus incentives*, and the *National 4IR Policy* provide a supportive environment for biosensor research and innovation. in biotechnology and technological innovation. is employed to examine the available literature on biosensor development in food

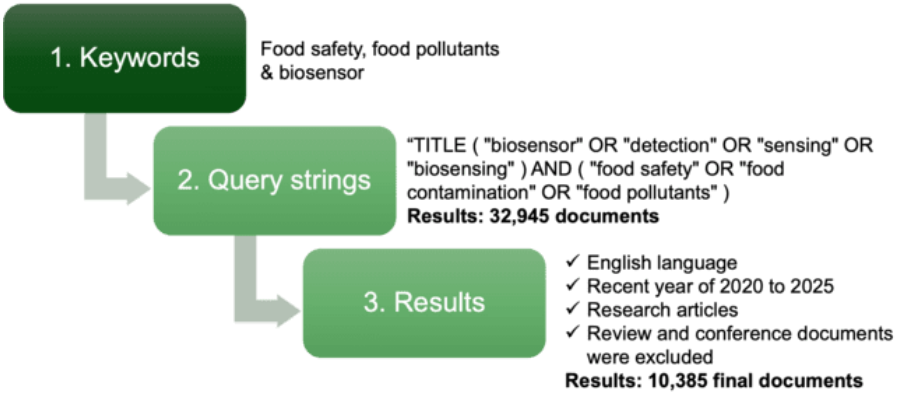


**Figure 1.** Summary of data collection process for bibliometric analysis.

safety application. Accordingly, this mini bibliometric analysis aimed to examine global and Malaysian publication trends in biosensor research for food safety.

## Methodology

### Search strategy and data collection

The bibliographic data focused on biosensor development for food safety application. The Scopus advanced search query was:

TITLE ("biosensor" OR "detection" OR "sensing" OR "biosensing")

AND ("food safety" OR "food contamination" OR "food pollutants")

As of February 21, 2025, this query produced 32,945 documents. After refining results to English-language research articles published between 2020 to 2025, and excluding reviews and conference papers, 10,385 documents remained. These were exported into CSV format for bibliometric analysis. **Figure 1** summarises the data collection process.

### Bibliometric analysis

Analysis were conducted using *Analyze Results* feature in Scopus and VOSviewer version 1.6.20 (developed by Nees Jan van Eck and Ludo Waltman, Centre for Science and Technology at Leiden University). Data were retrieved and analysed on the same day. Scopus provided information on publications trends, subject areas, preferred journals, leading countries,and prolific authors.

### Co-authorship and keyword co-occurrences analysis

The exported dataset was used to generate co-authorship networks and keyword co-occurrence maps. For country co-authorship, a minimum threshold of 70 documents was applied, resulting in 30 countries included. For keyword co-occurrence, a threshold of 300 occurances was set, yielding 125 keywords. Redundant or irrelevant keywords were merged or removed to ensure clarity and interpretability. These thresholds allowed the analysis to focus on the most active contributors and research themes.

## Results and Discussion

### Publication output, subject area and preferred journals

The final query yielded 10,385 documents published bewteen 2020 to February 2025.

**Figure *2*A** illustrates the global publication trend in biosensor development for food safety applications. In 2020, 1,626 documents were published, followed by a slight decline to 1,581 in 2021. From 2021 to 2023, output increased gradually, reaching 1,734 publications, before rising sharply in 2024 to 2,868 documents, indicating growing research interest. As of February 21, 2025, 916 documents had already been published, with numbers expected to increase by year-end. In Malaysia, 100 documents were published during this period, with the highest output recorded in 2024 (26 publications).

**Figure *2*B** highlights the top five subject areas: *Chemistry* (5,059 publication), *Agricultural and Biological Sciences* (3,796), and *Biochemistry, Genetics and Molecular Biology* (2,197). By contrast, related fields such as *Materials Science* and *Chemical Engineering* ranked only 10$^{th}$ and 11$^{th}$, respectively. Preferred journals in this domain are dominated by Elsevier and MDPI, as shown in **Figure 3**. *Food Chemistry* led with 1,158 publications, followed by *Talanta* (287) and *Sensors and Actuators B: Chemical* (279). These journals emphasise food safety, analytical chemistry, and sensor development, aligning closed with the theme of study.

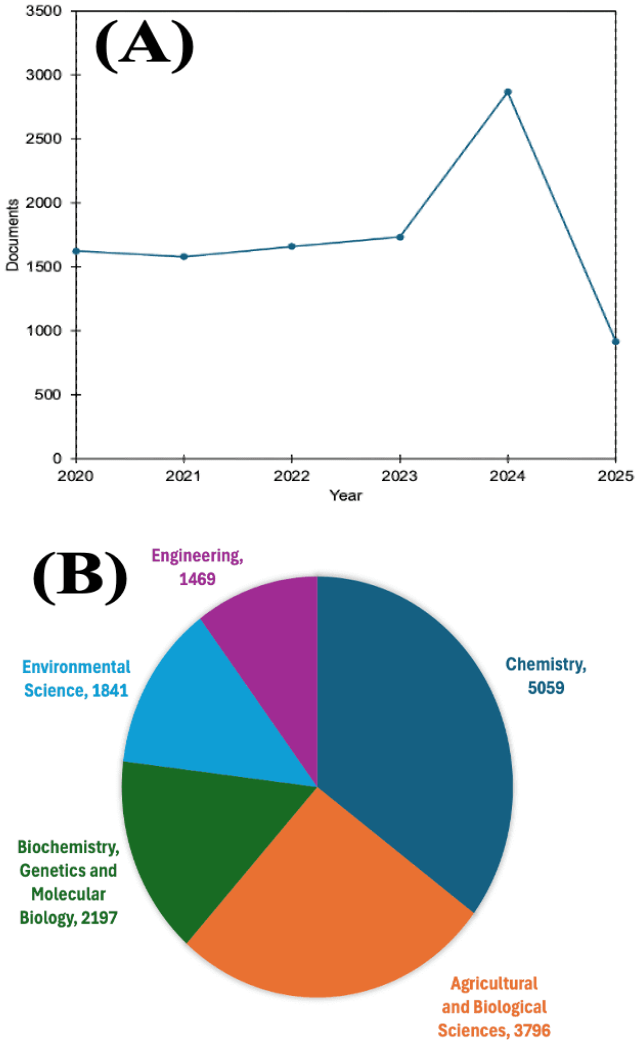


**Figure 2.** Global publication output in biosensor development for food safety (2020–Feb 2025) (A) and top five subject areas contributing to biosensor with a focus on food safety (B)

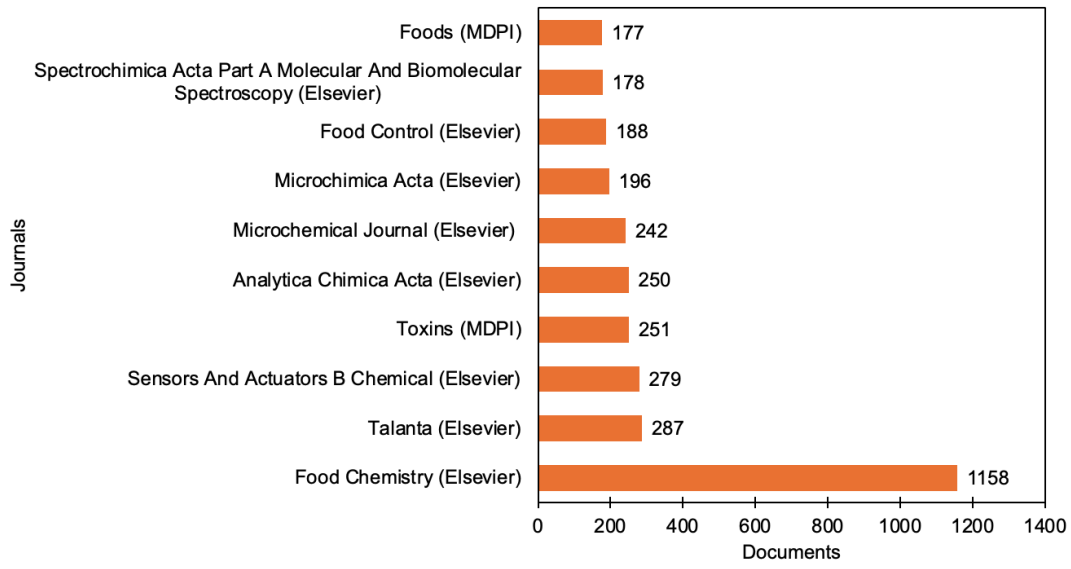


**Figure 3.** Top 10 journals publishing research on biosensor for food safety applications

**Countries co-authorship**

Research on biosensor for food safety has attracted contributions from 148 countries. The top 10 contributors span Asia, Europe, North America, and South America **(Figure 4A)**. Collectively, Asian countries produced 6,598 publications, underscoring the strong engagement of region. China leads with 5,556 publications, far surpassing other nations **(Figure 4B)**. Malaysia ranks 25$^{th}$ globally, while Thailand holds a strong position in Southeast Asia with 129 publications. To ensure clarity, countries with fewer than 70 publication were excluded, resulting in 30 countries included in the co-authorship analysis. **Figure 5A** presents the bibliometric map, where line thickness indicates collaboration strength [13]. As shown in **Figure 5B**, Malaysia demonstrates strong collaboration with Asian partners (green colour) particularly Japan, Thailand and Taiwan, forming a regional cluster. Malaysia also, collaborates extensively with developed countries such as the United States, Australia, Canada and the United Kingdom. These partnerships highlight active role of Malaysia. in global scientific networks. Various Malaysian universities have been instrumental in advancing this field **(Figure 6).** Universiti Putra Malaysia (UPM) led with 31 publications, including highly cited work on electrochemical aptasensors for zearalenone detection [14]. Universiti Malaya (UM) contributed 16 papers, highlighted by a dual-platform DNA biosensor for food adulteration [15]. Universiti Sains Malaysia (USM) produced 12 publications, featuring rapid gold nanoparticle-based lateral flow assays for simultaneous detection of Shigella and Salmonella [16].

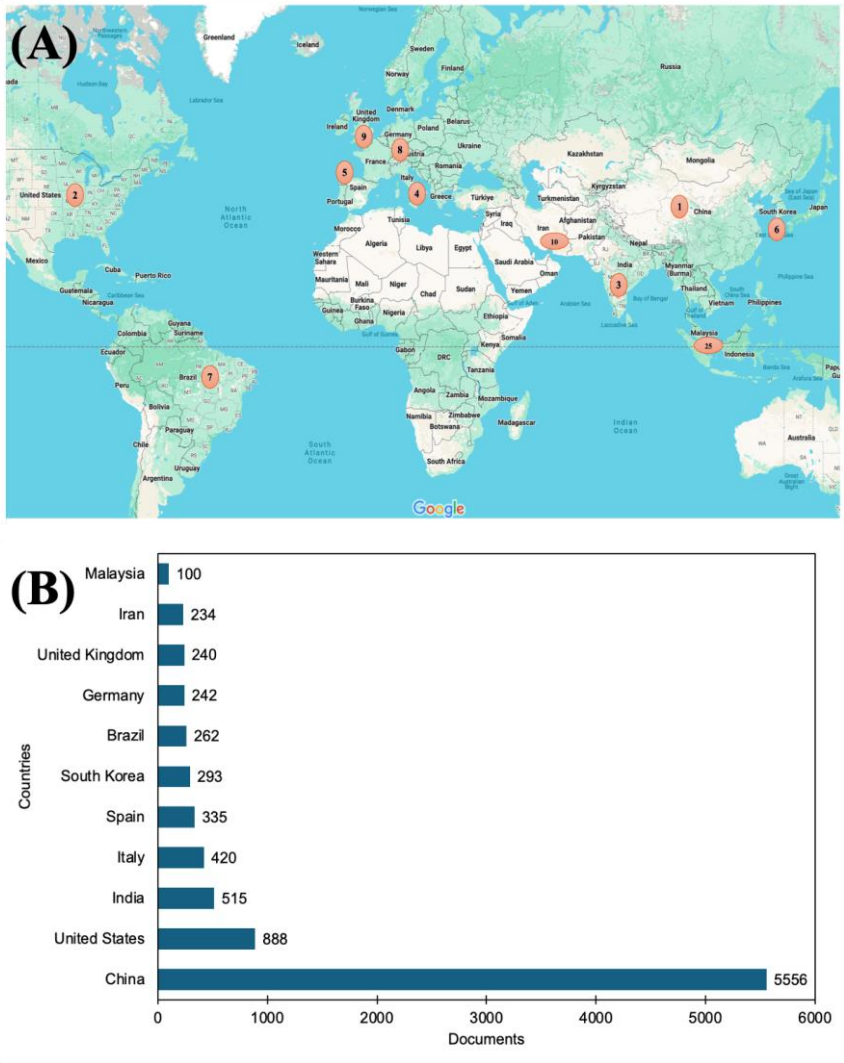


**Figure 4.** Geographic distribution of countries ranked by publication output (A) and publication output by individual countries (B)

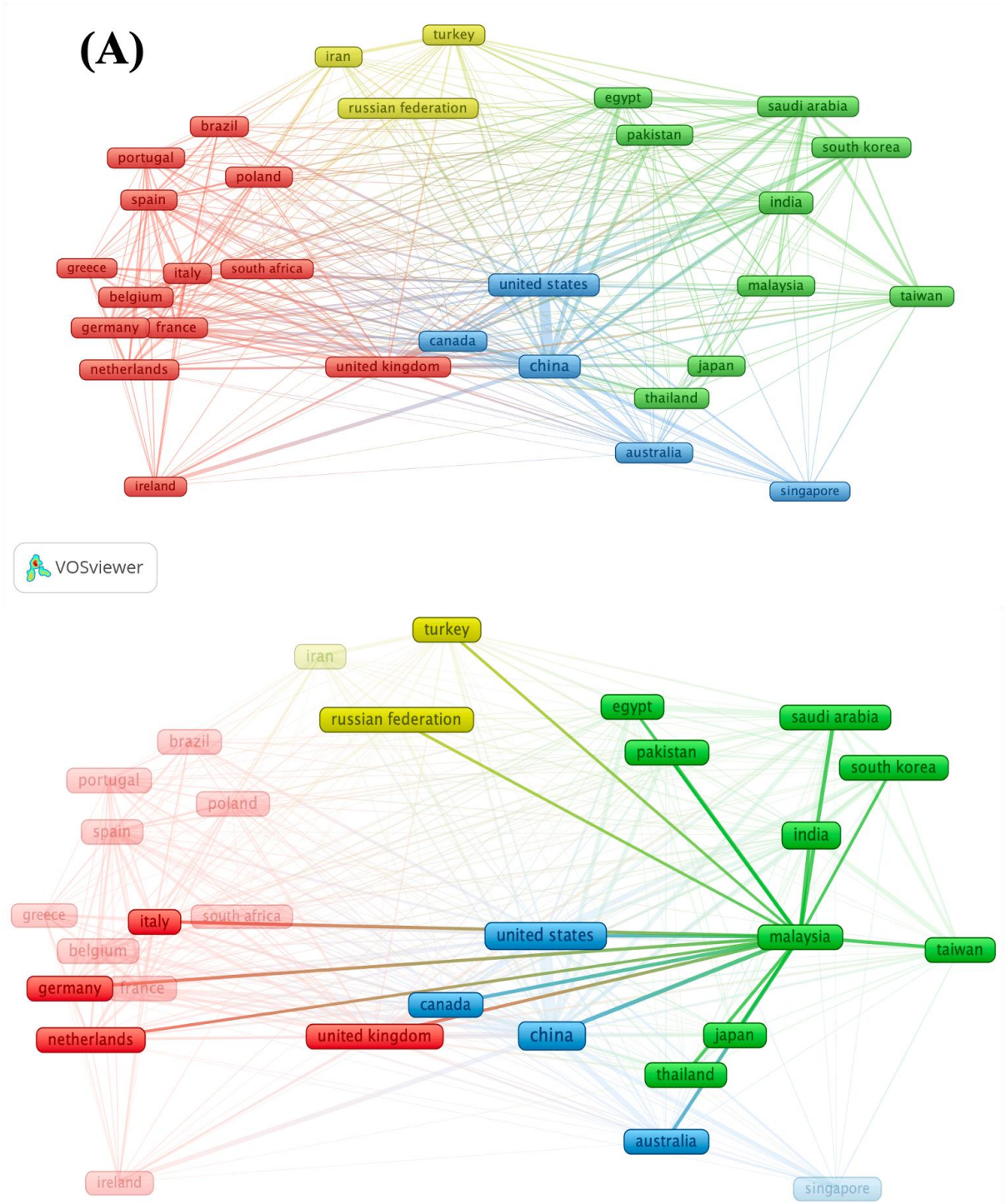


**Figure 5.** Global bibliometric map of countries co-authorship network (A) and Malaysia-focus co-authorship map highlighting international collaborations (B)

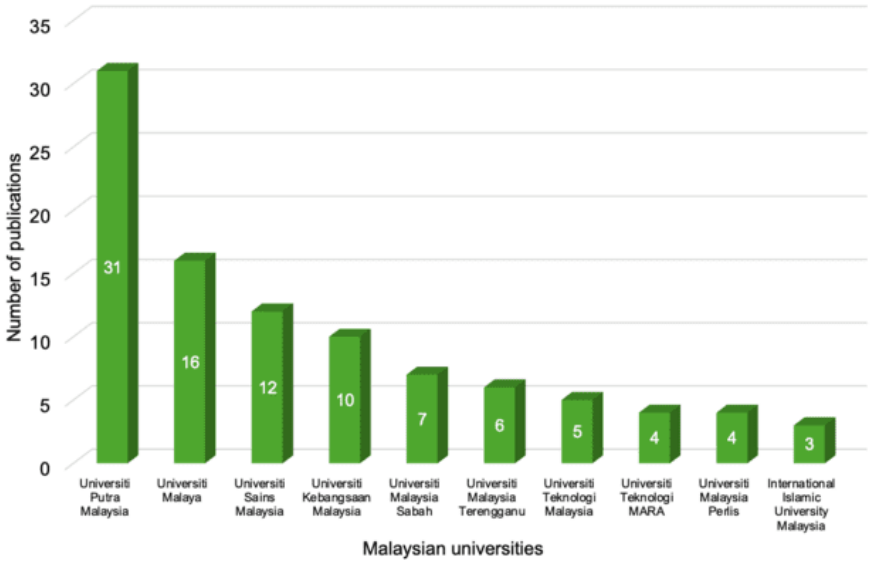


**Figure 6.** Top 10 Malaysian universities ranked by number of publications in biosensor research for food safety

**Keyword co-occurrences**

Applying a minimum threshold of 300 occurances yielded 125 keywords, of which 8 were excluded due to redundancy, leaving 117 **(Figure 7)**. High-frequency keywords include "*limit of detection*" (3,932), "*food safety*" (3,974) and "*biosensing techniques*" (1,037). These terms reflect the central focus of biosensor research in food safety. *The Limit of Detection (LOD)* is critical parameter in sensor research, referring to the smallest concentration reliably detected with statistical confidence [17]. Keyword co-occurrences analysis also reveals temporal shifts in research themes. Early studies (purple cluster) emphasised *mass spectrometry*, *microbiology* and *food analysis* reflecting foundational work in food safety. Mid-stage topics (green cluster) include *sensitive detection*, *metal nanoparticles* and *gold nanoparticles*. Recent trends (yellow cluster) highlight *metal-organic framework*, *colorimetry* and *electrochemical analysis*. This progression illustrates a technological shift from spectrometry-based methods towards nanomaterials-driven electrochemical detection techniques. Overall, the keywords analysis provides valuable insights into envolving research directions and emerging areas of focus.

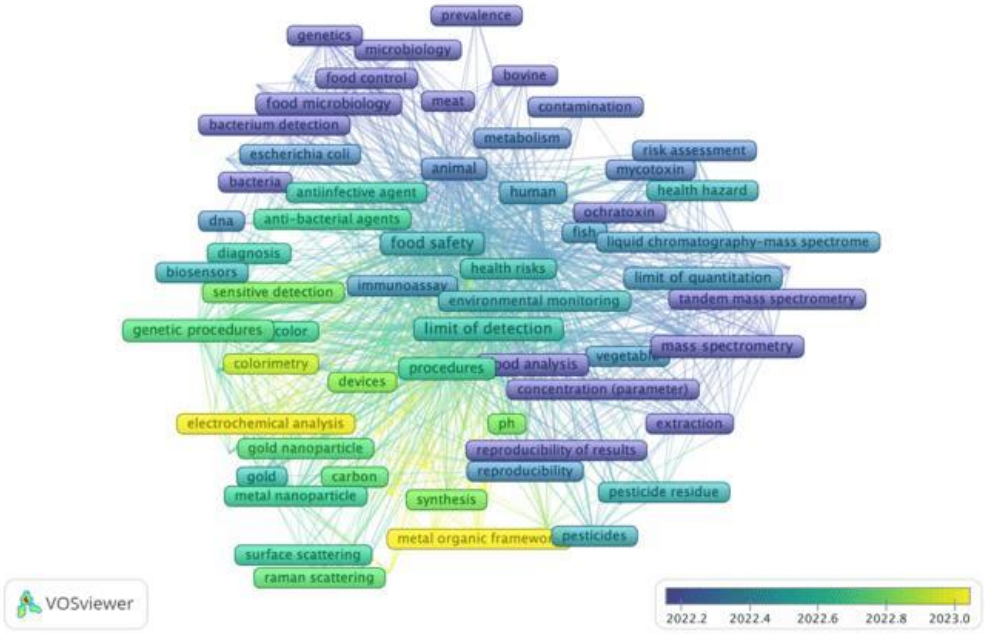


**Figure 7.** Global bibliometric map of keyword co-occurrences in biosensor research for food safety

**Limitation of study**

This study relied exclusively on the Scopus database, without incorporating records from other sources such as Web of Science (WOS). Search criteria were restricted to publications containing specific keywords (*biosensor, detection*, *sensing*, *biosensing*, *food safety*, *food contamination*, *food pollutants*). Consequently, relevant studies lacking these terms may have been excluded. Furthermore, only original research articles were analysed; conference papers, proceedings, book chapters, and review articles were excluded as mentioned in the methodology.

**Conclusion**

This bibliometric analysis, based on 10,385 documents published between 2020 and February 2025, highlights global and Malaysian trends un biosensor development for food safety. Publication output increase notably in 2024, with number expected to rise further in 2025. Malaysia conributed 100 publications during this period, peaking in 2024. Globally, research contributions came from 148 countries, with China leading (5,556 publications). Malaysia demonstrated strong international collaboration, particularly with the United States, China, and the United Kingdom. Local research universities, particularly UPM, UM, and USM played key roles in advancing biosensor research. Keywords analysis identified *limit of detection*, *food safety* and *biosensing techniques* as dominant themes, alongside emerging trends in nanomaterials and electrochemical detection. Overall, Malaysia is expected to expand its presence in this field, supported by increasing publication output, robust international partnerships, and active involvement from local universities.

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