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Molecular Based Foodborne Pathogen Detection Techniques; A Bibliometric Computational Analysis

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Abstract

Recent advances in molecular-based food pathogen detection technology and the increased complexity of the food supply chain make it critical to comprehend current trends and possibilities. This bibliometric study examined molecular-based detection approaches for foodborne pathogens during the past 15 years, including nation contribution, keyword trends, relevant journals, citations, and cutting-edge technology. Scopus returned 2114 documents. Vosviewer and R-Biblioshiny visualized the research. The annual number of publications fluctuated upward. The International Journal of Food Microbiology published the most, but the Journal of Biosensors and Bioelectronics had the most significant impact. The most cited articles described high-sensitivity foodborne pathogen detection methods such as PCR, multiplex PCR, real-time PCR, NASBA, LAMP, and FRET biosensors. China and the USA led the research publications, citations, and collaborations. The co-occurrence analysis of keywords indicates that "Real-time PCR," Isolation and Purification, "Genetics," "Biosensing Techniques," "RNA extraction," "Nucleic Acid Amplification," and "Rapid detection" were the main research priorities regarding the topic of food-pathogen detection. Meanwhile, "CRISPR/Cas12", "CRISPR-Associated Proteins," "LAMP assay," and Biosensing Techniques have trended in the past five years. These technologies and their integration imply prospective food safety innovation for researchers and the food sector.

A. Introduction

Foodborne pathogens continue to pose significant challenges to public health and food safety, with millions of cases reported annually. Data released by the World Health Organization (WHO) in 2015 indicate that 420.000 people die and 600 million people become ill every year as a result of eating contaminated food. Furthermore, in low-and middle-income nations, the annual loss in medical expenses due to unsafe food is US$ 110 billion. Food pathogens are microorganisms, including bacteria, viruses, and parasites, that can cause illness when consumed through contaminated food or water [1]. *Salmonella*, *Escherichia coli*, *Campylobacter*, *E. sakazakii*, *Pseudomonas fluorescens, L. ivanovii*, *Shigella sonneu*, and norovirus are among the most common foodborne pathogens that cause outbreaks in different countries. These pathogens can be found in a wide variety of foods and agricultural products, including meat, beef, carcasses, milk, powdered infant food (PIF), cheese, kefir, and many more [2], [3]. These pathogens can contaminate food at any stage of manufacturing, processing, distribution, or preparation. Once ingested, these pathogens enter the human body through the gastrointestinal system and can lead to foodborne illnesses [4], [5].

The food sector bears the primary responsibility for addressing the presence of harmful microorganisms, as failure to identify a pathogen could lead to significant implications. The exchange of tainted food among nations amplifies the likelihood of epidemics, thus making the health hazards associated with disease-causing microorganisms in food a significant apprehension for all governing bodies [6]. A reliable and effective food monitoring and control system is frequently required in addition to health education, import restriction, food inspections, and factory cleanliness, where that procedure must discover the diseases before or after they enter the food chain and contain infection sources before they spread or impact on the body [1], [7]. Developing detection technology that is rapid, highly sensitive, cost-efficient, real-time, and user-friendly is of utmost importance.

Traditional approaches to pathogen detection, such as culture-based techniques, have been instrumental in identifying and controlling outbreaks. Nevertheless, these methods frequently have drawbacks, including lengthy processing times, lower sensitivity, and the inability to detect living but uncultivable organisms or viable-but-non-cultural organisms (VBNC) [8], [9], [10]. Furthermore, no completely efficient culturing methods exist for foodborne viruses like norovirus [11]. Over the past few decades, molecular-based detection methods have revolutionized the field of microbiology. These techniques, which include polymerase chain reaction (PCR), real-time PCR, quantitative real-time PCR (qPCR), loop-mediated isothermal amplification (LAMP), recombinase polymerase amplification (RPA), and next-generation sequencing (NGS), offer rapid, sensitive, and specific detection of a wide range of pathogens [2], [11], [12], [13]. These technological improvements have played a role in improving outbreak investigations and the creation of targeted interventions. For example, Next-Generation Sequencing (NGS) has facilitated thorough pathogen profiling, enabling the precise analysis of microbial communities and the identification of particular strains responsible for outbreaks [14], [15], [16]. Molecular approaches have facilitated the identification of novel infections and enhanced our understanding of the genetics and evolution of familiar pathogens [17]

The advancements in molecular-based detection are ongoing. Researchers are developing new technologies, such as CRISPR-based detection and biosensor systems, to enhance detecting foodborne pathogens' speed, sensitivity, and specificity. Biosensors, especially electrochemical biosensors, have the potential for quick and on-site monitoring, thereby offering real-time information during the production process [18], [19]. CRISPR-associated proteins (CRISPR/Cas) are a highly effective method for detecting nucleic acids, which may be used in both laboratory scale or on-site testing. CRISPR-based technology can enhance the biosensors method and improve the performance of traditional nucleic acid-based methods such as PCR and other bioanalytical assays [20], [21].

The rapid advances in technology for detecting molecular-based food pathogens and the increasing complexity of the food supply chain make it essential to understand future trends and prospects for molecular-based research. Bibliometric analysis enables the systematic assessment of scientific literature to identify the most important research subjects, influential publications, and recent innovations. This study aimed to conduct a comprehensive bibliometric analysis of molecular-based techniques for detecting foodborne pathogens to visualize patterns and progress in this detection field. In addition, by compiling research data over the past fifteen years, this study intends to determine which countries are the most productive in publications, examine international cooperation, and focus on cutting-edge technologies that may impact future food safety. The expectation is that the outcomes of this study will offer valuable understanding for future research and development endeavors in the domain of food safety.

B. Research Method

Data Collection

Scopus data from scopus.com was used in this study. Data was taken once on July 11, 2024, to avoid modifications. The search query for the keywords is (TITLE-ABS-KEY (molecular AND foodborne AND detection) OR TITLE-ABS-KEY (real AND time AND PCR AND foodborne) OR TITLE-ABS-KEY (molecular AND food AND pathogen AND detection) OR TITLE-ABS-KEY (biosensor AND foodborne) OR TITLE-ABS-KEY (CRISPR AND cas AND foodborne)). Based on this keyword search, around 4382 documents were filtered. Then, several document restrictions were applied to obtain documents that met the research criteria. The selected documents were restricted to the time period from 2009 to 2024, encompassing the most recent 15 years. Searches were limited to articles exclusively, excluding reviews, book chapters, books, and conference papers from the collected data. Keyword searches were not subject to any language barriers. Furthermore, the scope of the subject area was confined to Agricultural and Biological Sciences, Biochemistry, Genetics, and Molecular Biology in order to exclude papers that do not concern the research aims. The total number of documents collected in this search was roughly 2114. To facilitate analysis, the data was downloaded in CSV format and organized using Microsoft Excel.

Data Analysis

The data was subsequently visualized using two bibliometric apps, specifically Vosviewer and the biblioshiny application built on R studio 4.4.0, which can be accessed for free at https://bibliometrix.org. R Studio 4.4.0 was used to visualize

data pertaining to the detection of foodborne pathogens using molecular methods. It allows for the display of the geographic distribution of collected documents and the analysis of various factors such as relevant sources, document production trends over time, influential authors, country productivity, cited documents, relevant keywords, research hotspots, and more. Meanwhile, Vosviewer was utilized to generate bibliometric graphic mapping and network visualization using bibliometric data, including co-authorship, co-citation, and co-occurrence keywords.

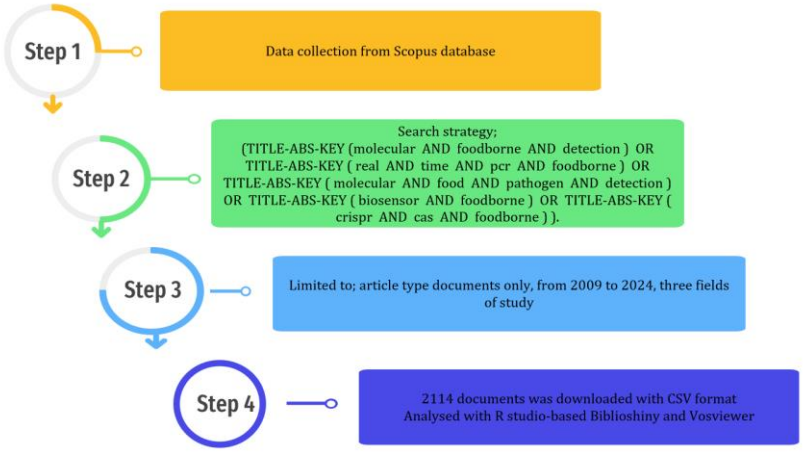


Figure 1. Flowchart of Bibliometric Analysis

C. Result and Discussion

Overall performance of chosen papers in the research field

This analysis comprised articles that were published from 2009 to 2024. A total of 2114 article documents have been extracted from Scopus, originating from 481 journals and including 8961 authors. A grand total of 2041 articles were composed in the English language, but the remaining articles were written in various non-English languages, in-cluding Chinese (54 articles), Korean (10 articles), Spanish (5 articles), and other lan-guages. The annual increase in the number of documents is 7.54%, and each document, on average, has 21.84 citations (Figure 2).

The annual publication count exhibits a variable upward trend over time, peaking at 235 articles in 2021 (Figure 3). The mean number of citations per article is 21.84. The year with the highest number of citations was 2017, not 2009, which is further back in time (Figure 4). The retrieved documents are published in journals originating from different fields of study. The three main fields of study related to this research are Agricultural and Biological Science, with 1217 articles; Immunology and Microbiology, with 1481 documents; and Biochemistry, Genetics, and Molecular Biology, with 826 articles. section may be divided into subheadings. It should provide a concise and precise description of the experimental results, their interpretation, as well as the experimental conclusions that can be drawn.

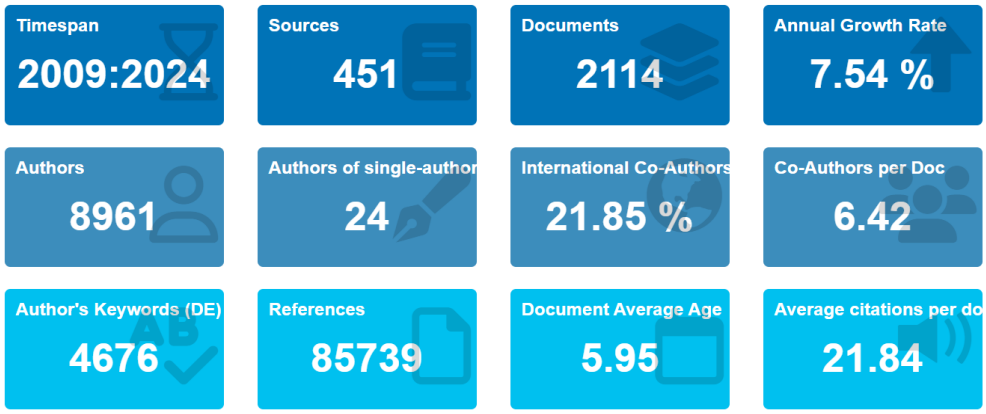


Figure 2. Overall performance of chosen papers in the research field

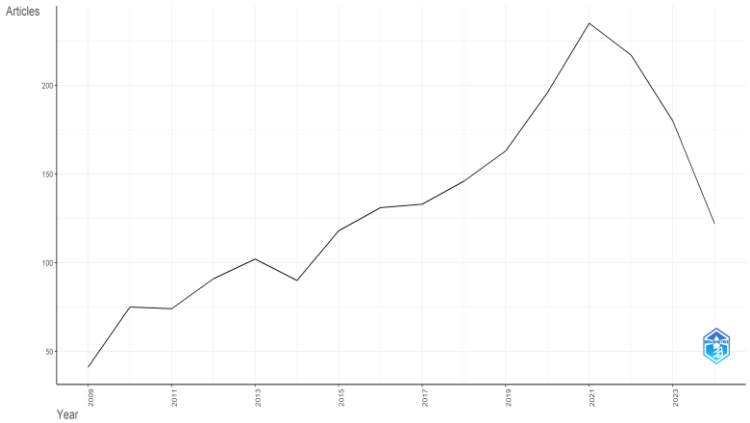


Figure 3. Annual scientific production of the research topic

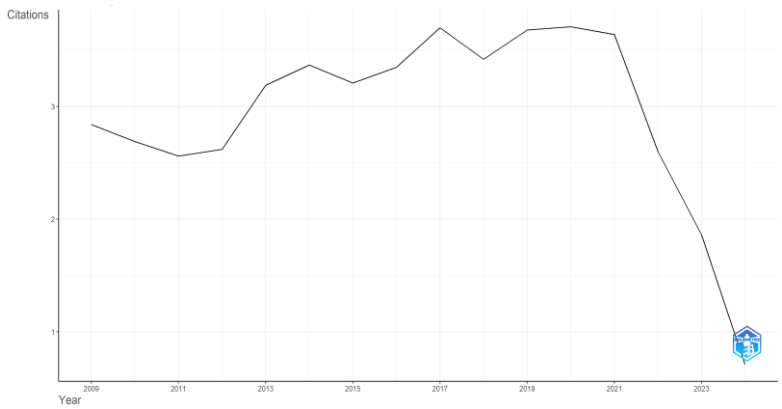


Figure 4. Avarage Citations Per Year

Most-productive and relevant sources

During the research period of foodborne pathogen molecular detection from 2009 to 2024, the International Journal of Food Microbiology published the highest number of papers, exactly 115. The Biosensors and Bioelectronics Journal and the Journal of Food Protection both had an equal number of publications, precisely 88 (Figure 5). However, the journal Biosensors and Bioelectronics has a more

significant impact factor compared to the International Journal of Food Microbiology, as indicated by the h-index, g-index, and m-index and the total number of citations (Table 1). Nevertheless, the International Journal of Food Microbiology is the second most influential publication compared to other journals such as Food Control Journal, Journal of Food Protection, Foodborne Pathogens and Disease Journal, and others. The amount of citations in a journal is correlated with the author's fame or impact among researchers. Additionally, citation impact facilitates collaboration among researchers and intensifies a journal's impact [22]. The h-index number also assesses a journal's impact on the scientific community in developing a research topic. The h-index accurately indicates the authors' relative number of publications and citations while reducing the influence of a few highly cited papers that do not represent the full body of work [23].

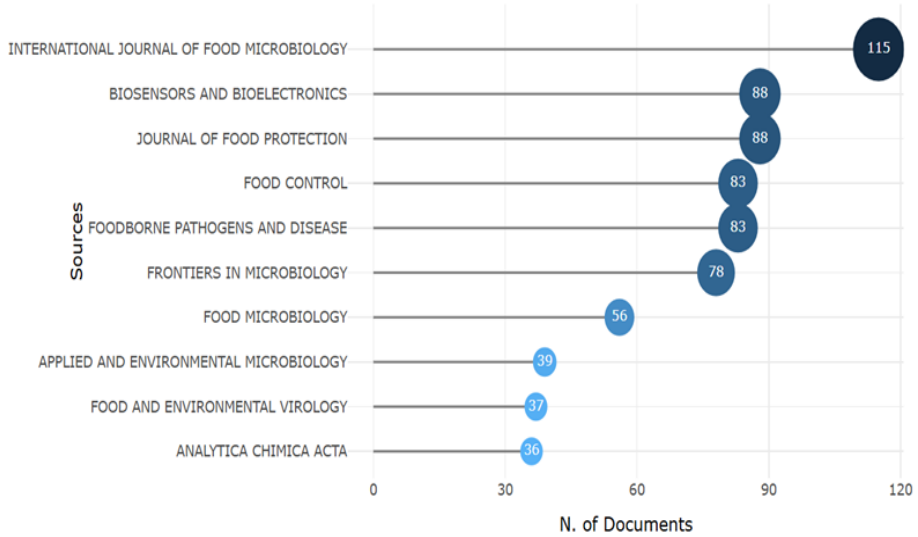


Figure 5. Most Productive Journal

The primary focus of the International Journal of Food Microbiology is the study of the identification and analysis of pathogens and toxins present in food. This subject is specifically pertinent to identifying foodborne illnesses at the molecular level. Meanwhile, the journal Biosensors and Bioelectronics primarily concentrates on advancing and utilizing biosensors and bioelectronics, which are pivotal technologies in molecular detection. These two journals are well-known for the high quality of their articles, which undergo a rigorous review procedure to ensure that only the best and most creative publications are published. A journal's reputation draws prominent researchers to submit their work, improving the quality and impact of their articles [24]. Moreover, the journals, as mentioned earlier, have a multidisciplinary focus, making them appealing to scholars from diverse fields and thereby enhancing the influence of the journals.

Table 1. Top 10 most relevant sources

No	*Source*	*h_index*	*g_index*	*m_index*	*TC*	*NP*	*PY_start*
1	Biosensors And Bioelectronics	49	76	3,063	5875	88	2009
2	International Journal of Food Microbiology	37	56	2,313	3854	115	2009
3	Food Control	28	42	1,867	2113	83	2010
4	Food Microbiology	26	37	1,625	1564	56	2009
5	Frontiers In Microbiology	25	48	2,273	2480	78	2014
6	Applied And Environmental Microbiology	23	39	1,438	1563	39	2009
7	Journal Of Food Protection	23	30	1,438	1346	88	2009
8	Foodborne Pathogens and Disease	22	32	1,375	1395	83	2009
9	Analytica Chimica Acta	16	32	1,333	1034	36	2013
10	Food And Environmental Virology	16	29	1,067	897	37	2010

Note: TC: total citation; NP: Number Productio; PY_start; production year_start

Most Cited Documents

The most cited document is the one entitled "*Rapid Methods For Detecting Foodborne Bacterial Pathogens; Principles, Applications, Advantages, and Limitations*" [8], cited 831 times in the journal Food Microbiology (Table 2). This paper is a review article that examines the most recent techniques for rapidly, accurately, and efficiently identifying foodborne pathogenic bacteria with high sensitivity and specificity. These encompass detailed conversations regarding PCR, multiplex PCR, real-time PCR, nuclear acid sequence-based amplification (NASBA), loop-mediated isothermal amplification (LAMP), biosensors, and other related topics. The above article is likely highly cited because it provides a comprehensive and up-to-date review of rapid pathogen detection methods, helping researchers, food industry professionals, and policymakers understand, select, and implement appropriate detection technologies and critically analyze their pros and cons. Additionally, this work was published in a top journal, boosting its visibility and credibility [25].

The second most referenced article is titled "*A fluorescence resonance energy transfer (FRET) biosensor based on graphene quantum dots (GQDs) and gold nanoparticles (AuNPs) for the detection of mecA gene sequence of Staphylococcus aeureus"* [26]. This article has been cited 305 times in the journal Biosensors and Bioelectronics. FRET is a sensitive technique that allows for high accuracy in molecular detection. FRET resonance energy transfer is ideal for exact quantification since it resists background fluorescence and the environment. Consequently, they have the capability to fulfill the requirement for rapid and sensitive detection. While FRET sensor technology remains challenging for on-site detection, these FRET advancements facilitate gene detection in molecular diagnostics [27]. Technology that provides a fast, accurate, innovative, and relevant solution for food safety or biotechnology attracts researchers from other fields to use or create it [28]. Additionally, innovative, clinically relevant, practical, commercial, and research-contributing articles will likely be cited.

Table 2. Top 10 most global cited document

No	Paper	DOI	Total Citations	TC per Year
1	Law Jw-F, 2014, Front Microbiol	10.3389/fmicb.2014.00770	831	75,55
2	Shi J, 2015, Biosens Bioelectron	10.1016/j.bios.2014.09.059	305	30,50
3	Shanks Oc, 2011, Appl Environ Microbiol	10.1128/AEM.02988-10	279	19,93
4	Endersen L, 2014, Annu Rev Food Sci Technol	10.1146/annurev-food-030713-092415	250	22,73
5	Joshi R, 2009, Mol Cell Probes	10.1016/j.mcp.2008.10.006	243	15,19
6	Piliarik M, 2009, Biosens Bioelectron	10.1016/j.bios.2008.08.012	228	14,25
7	Wang Y, 2016, Compr Rev Food Sci Food Saf	10.1111/1541-4337.12175	218	24,22
8	Pintó Rm, 2009, Appl Environ Microbiol	10.1128/AEM.01177-09	218	13,63
9	He Y, 2016, J Nanobiotechnology	10.1186/s12951-016-0202-0	211	23,44
10	Park Bh, 2017, Biosens Bioelectron	10.1016/j.bios.2016.11.063	199	24,88

Analysis of Main Research Countries/Areas Distribution Characteristics

Table 3 shows that China produced 3736 molecular-based foodborne pathogen detection publications from 2009-2024, followed by the USA with 1927 and South Korea with 765. The dark blue tint indicates the most productive countries, such as China and the US, while the gray tone indicates the least productive countries. Only eight Indonesian authors have published documents regarding molecular foodborne pathogen detection, highlighted in light blue color (Figure 6).

Table 3. Most productive countries

No	Country	Freq
1	China	3736
2	USA	1927
3	South Korea	765
4	Italy	756
5	India	449
6	Spain	421
7	Canada	397
8	Germany	394
9	Brazil	382
10	Japan	348

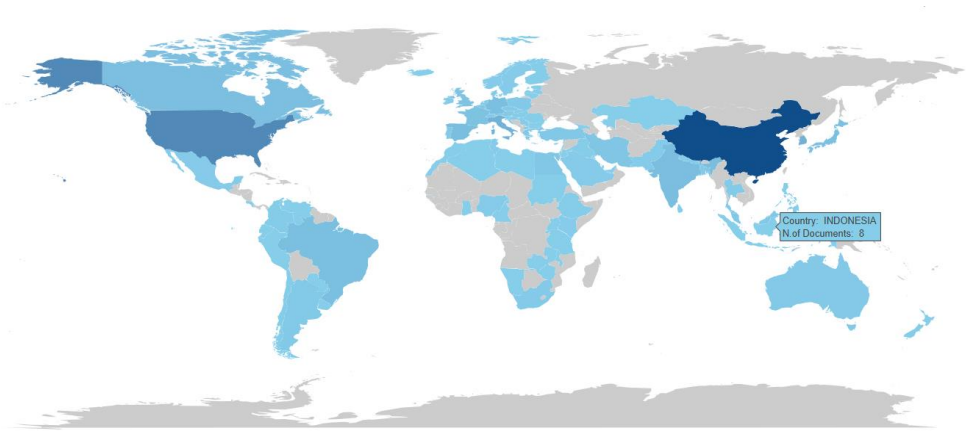


Figure 6. Document productivity worldwide and Indonesia

Figure 7 shows these countries' strong productivity is closely proportional to their high document citation rates. China and the US have the highest document citation rates, 9029, followed by Spain and Korea, with 2433 and 2422. These countries have great productivity and are capable of publishing research papers in journals with a significant impact factor in the study of molecular foodborne pathogen detection. China and the United States are heavily involved in the global food trade, and food safety is a critical problem between the two nations, with an urgent need to ensure that food items in both countries are safe and pathogen-free [29].

Figure 8 depicts international collaboration through cooperative academic publications. VOSviewer finds and visualizes cross-country correlations based on the number of scientific publications authored by authors from various nations. Nodes or dots represent participating nations, with larger nodes indicating more publications. The lines linking nodes represent country collaboration. Colors or density indicate clusters or collaborative groups. Countries within a cluster exhibit strong interrelations. For instance, China, USA, Australia, Canada, Ethiopia, India, Iran, Japan, Kenya, Malaysia, New Zealand, Nigeria, Philippines, South Africa, South Korea, Thailand, and the United Arab Emirates belong to the same cluster or share the same color. These nations collaborate closely on publications related to detecting foodborne pathogens using molecular-based techniques.

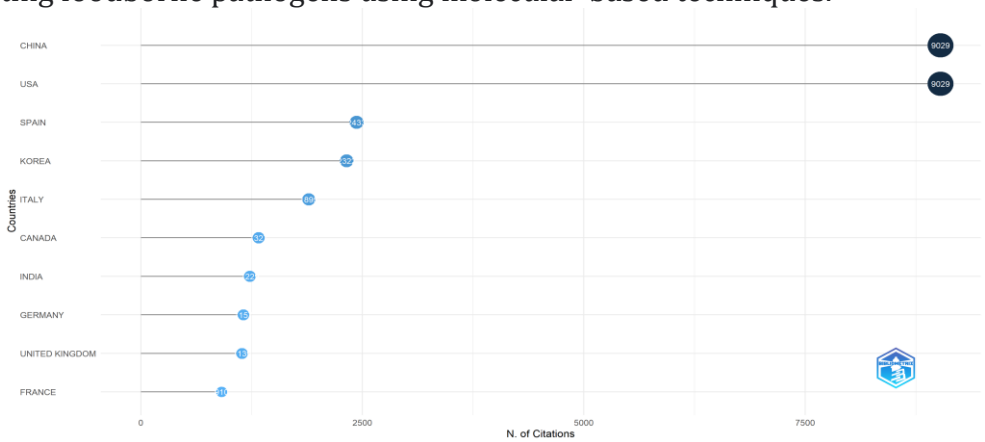


Figure 7. Top 10 most cited countries showed by *Biblioshiny*

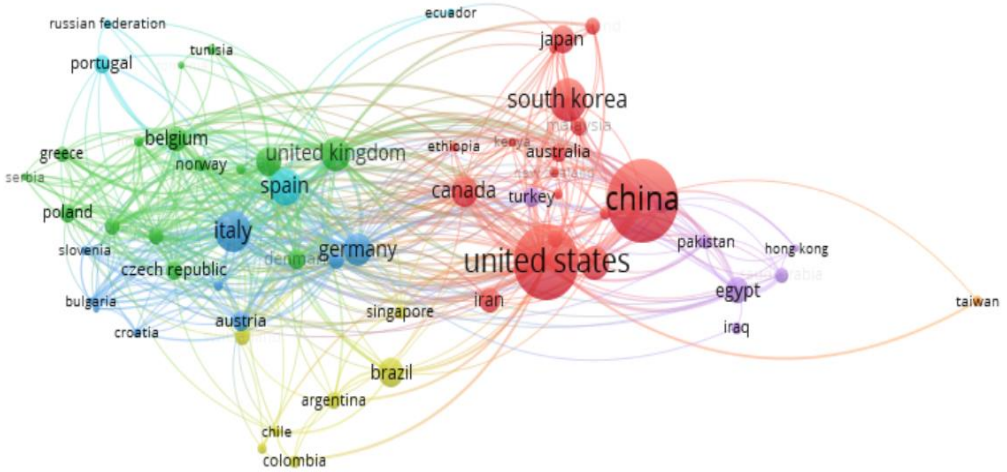


Figure 8. Co-authorship country or country collaboration

China and The USA have massive nodes, indicating that they have the most publications or are the most productive on molecular-based foodborne diseases. Additionally, these two countries collaborate the most with other nations. Figure 9 displays the top 20 author's countries' MCP (multi-country publications) and SCP (single-country publications) values. China and the USA are the countries with the most other countries working together (shown by the orange bars). These are also the countries with the most researchers from their own countries working together. Interestingly, Malaysia is one of the ASEAN (Association of Southeast Asian Nations) countries listed as one of the top 20 countries working closely with other nations (Figure 9).

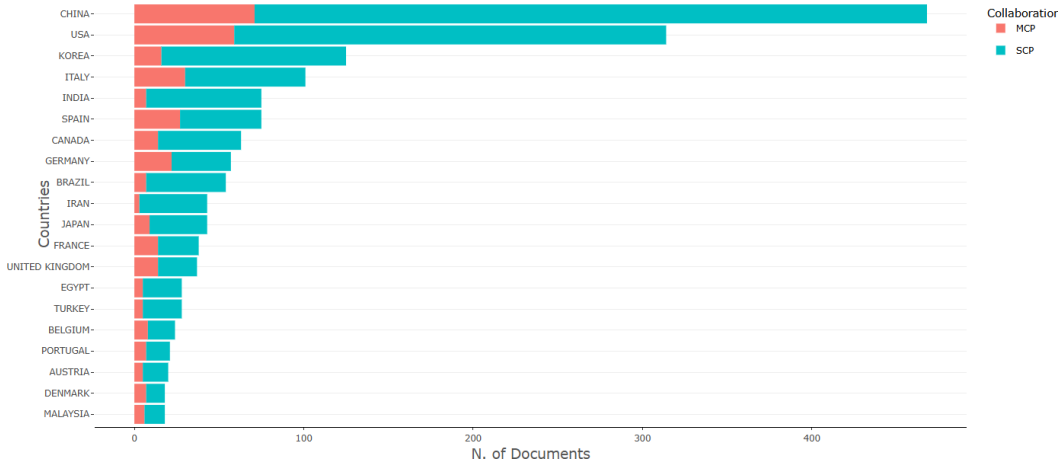


Figure 9. Top 20 corresponding author's country

Three plot field

Three plot fields (Figure 10) indicate the association between three constituents: the name of the most prolific journal, the author's country, and most keywords often appearing with the author's country and productive journal. Gray lines connect these three components. All countries are actively conducting research on the keywords mentioned. The top ten most productive writing countries also

produce articles in impact journals, indicating great productivity. *Salmonella* is the most commonly used keyword in papers related to the most prolific journals and author countries, indicating that detecting *Salmonella* pathogens remains the primary focus of foodborne pathogen control. *Salmonella* is a prevalent organism that causes foodborne illnesses, including fever, typhoid, gastroenteritis, and systemic infections [30]. The high frequency of this keyword demonstrates the widespread prevalence and significance of *Salmonella* infections on public health.

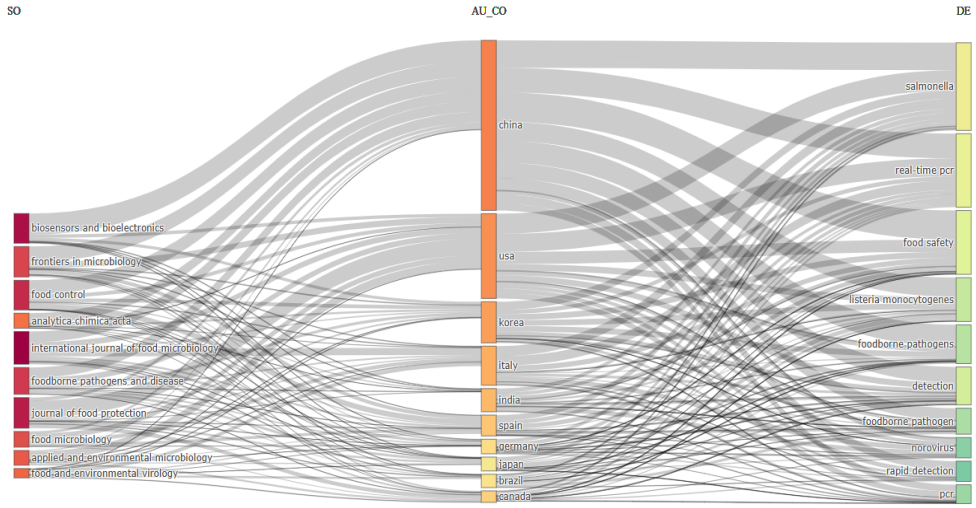


Figure 10. Three pot fields with three components including a list of journals, author nations, and keywords.

Co-occurrence network analysis of author keywords

Co-occurrence analysis finds keywords that appear together in molecular-based foodborne pathogen detection publications. The analysis offers a complete perspective of the link between subjects, concepts, or research domains. Keyword co-occurrence analysis visualized with the VOSviewer. The minimum number of keyword occurrences was set at ten among 14,368 keywords; 1041 keywords matched the criterion, and 500 keywords with the highest total link strength were chosen. A bibliometric visualization map and the association between molecular-based pathogen detection keywords from Scopus publications in the previous 15 years are shown in Figure 11. Analysis shows four primary groups with strong relationships, separated by color.

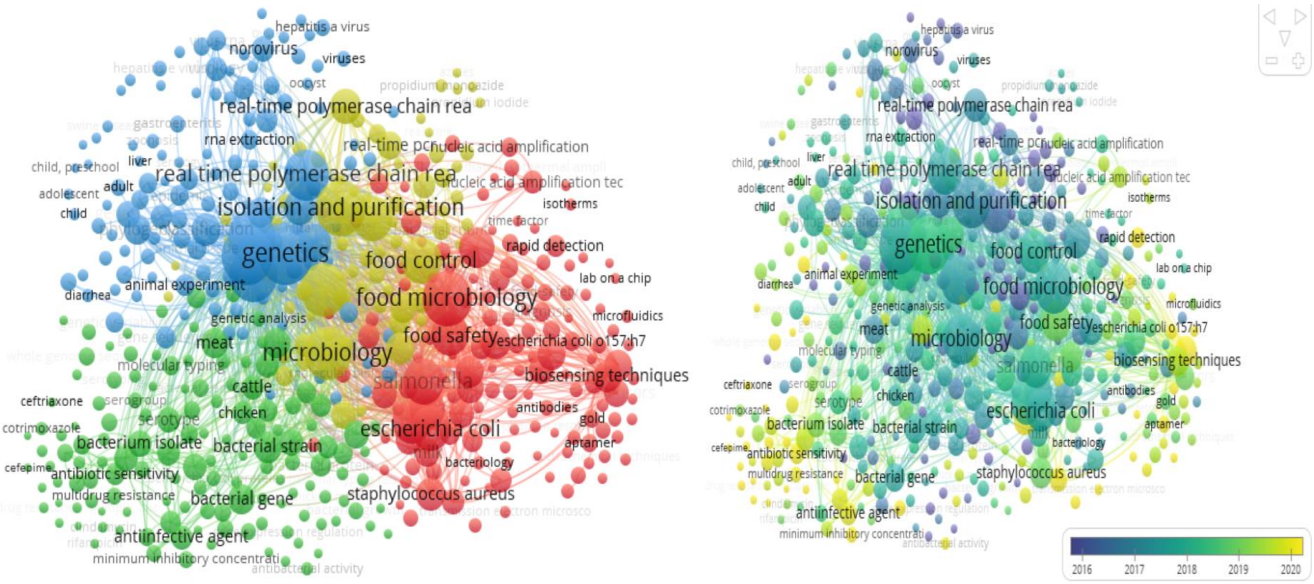
The yellow cluster co-occurrence in Figure 11a shows that "Real-time Polymerase Chain Reaction (PCR)," "nucleic acid amplification techniques'," and "RNA extraction" are still essential for molecular pathogen detection. Real-time PCR is the most frequently employed method for amplification of nucleic acids in order to identify pathogens. As technology advances, numerous protocols related to PCR have been developed, particularly for detecting diseases caused by *Salmonella, Listeria*, and *Escherichia coli* [2]. Despite its fast, specific, and sensitive detection capabilities, PCR cannot distinguish DNA from living and dead cells. Therefore, various methods are combined with it, such as cell viability dyes like Ethidium monoazide (EMA) or Propidium monoazide (PMA) [31]. Molecular-based diagnostic procedures like RT-PCR use RNA extraction to turn it into cDNA and amplify it to detect diseases at low RNA levels [32].

Molecular detection and genetic testing are the blue cluster's focus. The blue cluster also consists of the keywords "Isolation and purification," "Genetics," “Phylogeny,” and “Genotype.” These keywords are significant in pathogen identification processes. Isolation and purification play a crucial role in food safety detection to guarantee the deployment of accurate detection methods [33].

The green cluster, focuses on microbiological aspects and bacterial characterization. Keywords showed in this cluster include "microbiology," "bacterial strain," "antibiotic sensitivity," "serotype," "chicken," "meat," and "and cattle." These topics are highly relevant for identifying the virulence and resistance of pathogenic bacteria. Apart from that, this topic demonstrates the origin of infections, many of which are derived from animals. The visualization of this cluster also reveals that research into antibiotic resistance and bacterial genetics is being undertaken in the context of food safety. Mechanisms of resistance, microbial genetics, and the development of cutting-edge detection tools are all areas where research might be focused.

The fourth cluster, referred to as the red cluster, encompasses terminology associated with cutting-edge technology in the rapid identification of pathogens, including biosensor technology. The key terms in this cluster include "rapid detection", "biosensing techniques", "biosensor", "chemical detection", "Food Safety", "*Salmonella*", "Loop-mediated isothermal amplification", "lab-on-chip", "crispr-cas system", "*Escherichia coli*", "*Listeria monocytogenes",*"Aptamer", and "gold nanoparticle". Biosensor technology has advanced over the previous five years because it can be used to examine materials outside the laboratory, allowing for rapid detection of epidemics. As a result, various biosensor technologies, such as immunosensors, nucleic acid-based biosensors, phage-based and mammalian cell-based biosensors, light scattering sensors, and lectin-based biosensors, are being developed in order to make their applications more practical and to advance the practical usefulness of each type [34], [35].

All of the clusters above contribute to the development of molecular-based foodborne pathogen detection technology that is more inventive, rapid, sensitive, and accurate to ensure food quality and safety. Additionally, bibliometric analysis in molecular pathogen detection studies suggests future research prospects as words evolve from 2009-2024 (Figure 11b). Yellow keywords include "biosensing techniques", "whole genome sequences", "multilocus sequence typing", "electrochemicals biosensors" and "loop-mediated isothermal amplification" are the latest trend in rapid detection in food safety controls.



(a) (b)

Figure 11. (a) Cluster of keywords from the studies on molecular-based pathogen detection (b) Cluster maps of keywords from the field of molecular-based pathogen detection between 2009-2024

Trending topics and future research in molecular-based foodborne pathogen detection techniques

In Figure 12, a bibliometric timeline graph depicts keywords or trending topics connected to molecular-based food pathogen detection research from 2009 to 2024. Most research in this area focuses on technique development and optimization, such as real-time PCR, nucleic acid amplification, and biosensing.

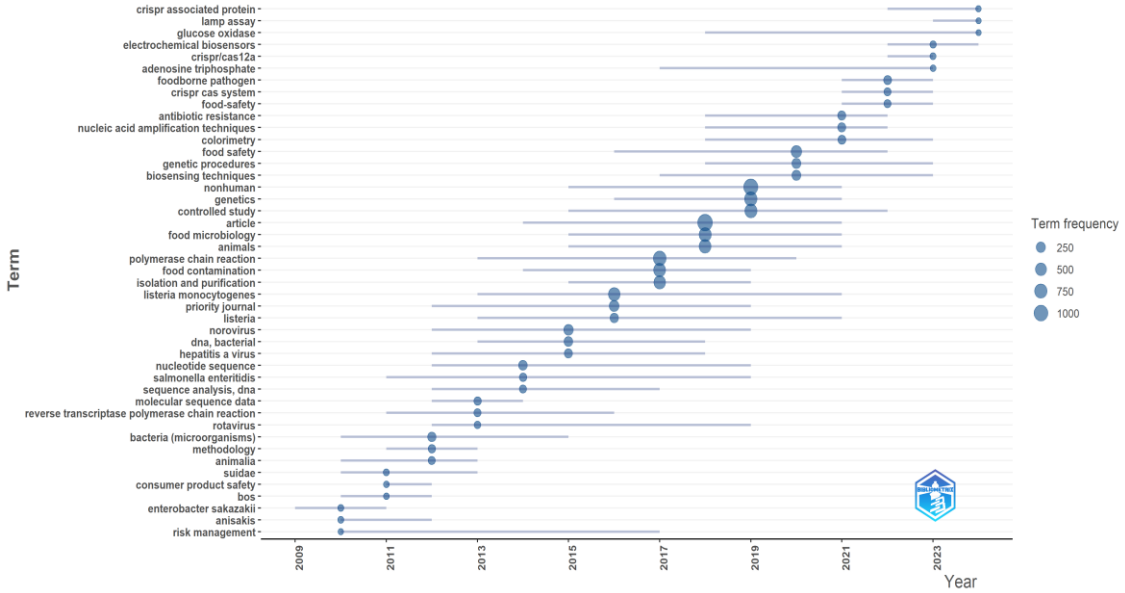


Figure 12. Timeline visualization of research trends in molecular-based food pathogen detection techniques

The topic or technology of "Reverse transcriptase polymerase chain reaction" was the subject of intense study between 2011 and 2016. The “Polymerase chain reaction” study was conducted intensively between 2013 and 2021. The “nucleic acid amplification” techniques underwent considerable research between 2018 and 2022. These three subjects have gained popularity as research topics over the years. The PCR technology is crucial for pathogen detection due to its rapid and precise results. Nevertheless, traditional PCR is less cost-effective and practical; thus, new technologies are created to address its drawbacks. Using the photothermal effect and thermal conductivity of gold nanoparticles and integrated digital multiplex PCR, *Escherichia coli, Listeria monocytogenes, Staphylococcus aereous, and Salmonella* can be detected in 20 minutes [36]. Isothermal nucleic acid-based detection technologies like sequence-based amplification (NASBA), Hybridization Chain Reaction (HCR), Rolling Circle Amplification (RCA), Loom-mediated isothermal amplification (LAMP), and Recombinase Polymerase Amplification (RPA) are being developed as alternatives to expensive and complicated PCR [37]. In addition, nanomaterial-based nucleic acid assays can detect infections in various food matrices on-site [38].

The key issues explored in the previous three years include "CRISPR/Cas12a," "electrochemical biosensors," "CRISPR associated protein," and "LAMP assay." Meanwhile, research on "Biosensing Techniques" has been extensively pursued since 2017 and continues to grow significantly. The increased emphasis on these technologies can serve as a novelty in future research related to molecular pathogen detection. The integration of these techniques can also lead to innovation, sensitivity, and speed in pathogen detection. Based on Figure 13, it is evident that the research area on the CRISPR-Cas system is not extensively connected to other research areas. Therefore, it presents an opportunity for further development by researchers.

Figure 13. Keywords co-occurance of crispr-cas systems based on Vosviewer analysis

The CRISPR-Cas system is a precise genetic technique used for DNA modification. [39], combine the CRISPR/Cas system and recombinase polymerase amplification (RPA) to molecularly detect *Vibrio vulnificus.* Additionally, a portable biosensor utilizing CRISPR-Cas12a and photothermal activation was created. This biosensor combines hybrid branch chain reaction (bHCR) and metalized DNA to precisely identify the presence of *Staphylococcus aereous* and *Listeria monocyteges* [40]. Calorimetric nanoprobes based on CRISPR-Cas mediated techniques have significant promise for point-of-care diagnostics [41].

D. Conclusion

In conclusion, this bibliometric study provides insight into the evolution and trends of molecular-based foodborne pathogen detection research over the past 15 years. The Journal of Biosensors and Bioelectronics has the highest h-index, g-index, and m-index, although the International Journal of Food Microbiology publishes the most on this topic. The review papers that examined methods for more precisely, sensitively, and effectively detecting pathogens are the most cited, with 831 citations, followed by publications about Fluorescence Resonance Energy Transfer (FRET) technology, with 305 citations. China and the US are the most productive countries in molecular foodborne pathogen detection research, with the most citations and collaborative networks. *Salmonella* is the pathogen most mentioned in top research countries and journals. Co-occurrence analysis of author keywords and trending topic analysis show that publications generally focus on PCR-based detection techniques, to the latest innovations, namely CRISPR and biosensing. Ongoing research is being conducted to tackle food safety concerns and enhance the efficiency and precision of pathogen identification. CRISPR/Cas12, CRISPR-Associated Proteins, LAMP, and Biosensing Techniques have been popular research subjects in the last five years. This technology and its integration with other technologies indicate promising future trends for researchers and the food industry to overcome food contamination and pathogen resistance. In addition, adopting the most recent technology with a multidisciplinary approach to address challenges and ensure food safety is the most recent development in future research.

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