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Global Bibliometric Analysis of Endophytic Actinomycetes From 2013 to 2023

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Abstract. Endophytic actinomycetes isolated from surface-sterilized of several plant species. These bacteria are also known as producers of plant growth regulators and hormone synthesizers, innovative resources in plant disease control. The aim of this study is to identify keywords and contributions of authors, countries, and institutions of actinomycetes endophytes research in the world for ten years (2013-2023) from the Scopus database. This research uses the bibliometric analysis method. Data were extracted from the Scopus database with the specified keyword query: Endophytic Actinomycetes using Publish or perish 8. Selected bibliometric details were performed and visualized by VOSviewer. The results from the beginning search of publications were obtained from 170 articles; according to the content, there are 145 articles. The analysis, facilitated by VOSviewer software, focused on 353 keywords with a frequency of 1 or more. All keywords were systematically grouped into 76 clusters. The investigation spans the last decade and identifies the top ten keywords: endophytic actinomycetes, 16S rRNA, Polyphasic Taxonomy, Streptomyces, Antimicrobial activity, Medicinal Plants, Antifungal, *Oriza sativa*, Plant growth Promoting, Indole-3-Acetic Acid. The most productive author is Liu Chongxi, Followed by Xiang Wencheng. Countries contributing: China, Next Thailand, India, Japan, Vietnam. Institution published, Northeast Agricultural University, Kasetsart University, Chulalongkorn University, Jiangsu Normal University.

Keywords: Bibliometrics, Endophytic actinomycetes, Scopus database, VOSviewer

INTRODUCTION

Actinomycetes, one of the main species widely used in biological activities, represent a group that performs useful functions, such as antibacterial effects, fragmentation of organic matter, and solubilization of minerals. They are also known as producers of plant growth regulators used in agriculture (Ali et al., 2021). Research on endophytic actinomycetes continues to understand their interactions with host plants and their potential as natural resources to enhance sustainable agricultural productivity. Their

presence has attracted attention because of their potential. Actinomycetes are gram-positive, GC-rich microorganisms called fungi-like bacteria that are produced through spores (Almaary et al., 2021). Endophytic actinomycetes were isolated from surface-sterilized of several plant species. Endophytic microorganisms, especially bacteria or fungi, establish a habitat within the cells and often in the intercellular spaces of healthy plant tissue without causing apparent disease symptoms. Numerous bioactive secondary metabolites are thought to be potentially produced by endophytic microorganisms connected to medicinal plants(Vu et al., 2020)(Taechowisan et al., 2022).

Research and publication on endophytic actinomycetes involves molecular characterization to identify species and genes in symbiotic relationships with plants. (Klykleung, et al. 2020) Genomic analysis of endophytic actinomycetes provides opportunities to understand their adaptation mechanisms to the plant tissue environment. Furthermore, studies encompass the exploitation of the bioactive potential of endophytic actinomycetes, such as antibiotics, enzymes, and other secondary metabolites that may find applications in agriculture and the pharmaceutical industry. (Pratiwi et al. 2020). Biotechnological strategies are also being developed to enhance the ability of endophytic actinobacteria to promote plant growth and reduce the reliance on chemical fertilizers. With a deeper understanding of the ecological roles and applicative potential of endophytic actinobacteria, this research contributes to building more sustainable and environmentally friendly agricultural systems. (Ali et al. 2021).

Studies on actinomycetes endophytes can be found in various journal indexing databases. Scopus is a widely referenced indexing database for research (Karobari et al., 2021). For example, using the keyword "actinomycetes endophytes," all articles indexed in Scopus will appear. The number of publications can indicate the extent of research on actinomycetes endophytes. However, the results often include articles, books, book chapters, proceedings, research reports, reviews, papers, and working papers. Therefore, there is a need for mapping research on actinomycetes endophytes using bibliometric analysis methods(Ma et al., 2022). Bibliometrics is a scientific approach that utilizes quantitative methods to analyze scholarly literature. In mapping research sources, bibliometrics is employed to evaluate and measure the impact and distribution of research sources in a particular field or discipline (Victoria & Gomathi, 2021). Bibliometric analysis provides insights into research trends, collaboration among researchers, and the relevance and contribution of a study to the advancement of knowledge. Therefore,

mapping research sources through bibliometric approaches becomes a crucial tool for understanding the structure and dynamics of scholarly literature (Dodino-Gutiérrez et al., 2023).

One advantage of using Scopus as a journal indexing database is multidisciplinary coverage; corpus covers journals from various disciplines, including science, engineering, medicine, social sciences, and humanities, allowing researchers to easily find information from diverse fields. (Ahmed et al. 2023). High-quality journals: Scopus has strict criteria for selecting indexed journals, so the listed journals tend to be of high quality and have undergone peer-review processes. Research performance metrics: Scopus provides various research performance metrics, such as the Hirsch index (h-index), citation indices, and others, allowing researchers to evaluate the impact and productivity of their research and compare it with others (Xu et al. 2022). For international research, Scopus is an international database that includes journals from around the world, enabling researchers to access and collaborate with researchers from various countries. Access to citation details: Scopus provides detailed citation information for each article, including citations from journals not indexed in Scopus. Scopus is one of the top choices for searching and evaluating scientific literature. (Anumudu et al. 2022).

Previous research on bibliometrics was used to Identify the growth and trends in AMPs study in the treatment of drug-resistant bacteria and to map the knowledge structure of scientists, analysis utilized to know whole and systematic review of articles about phytoremediation of cadmium-contaminated soils, study on diesel contaminated marine water bioremediation by bacteria, complete bibliometric study of mycological research trends in Egypt. There is limited research on bibliometric analysis in the field of science. (Dodino-Gutiérrez et al. 2023). This study is important because, based on previous research, there is no study for mapping and evaluation of research on endophytic actinomycetes.(Sun et al. 2022). This study aims to map research trends, analyze collaboration patterns among authors, and assess the productivity and development of endophytic actinomycetes research by Scopus article data from 2013 to 2023 using bibliometric analysis methods. This article contributes to reporting research on the rarely explored topic of endophytic actinomycetes for future research.

METHOD

This research uses the bibliometric analysis method. It consists of two main steps: data collection and subsequent data cleansing, and Analysis and mapping of the acquired data.

Data collection and subsequent data cleansing

Bibliometric data were extracted from the Scopus Collection database (2013 to 2023) using a specified keyword query: “Endophytic Actinomycetes” by Publish or perish 8. They are extracting data from Scopus using the Publish or Perish (PoP) application due to its capability to filter data and display results from journal articles only. Additionally, the process of storing and categorizing data is more accessible with PoP. Generated data consists of titles, author names, publication years, journal names, publishers, and citation counts. The next step involves sorting data processes. Additionally, data was completed using the Mendelay application."

Analysis and mapping of the acquired data.

Selected bibliometric details were gathered about keywords, authors, journals, subject categories, institutions, countries, publication years, citation counts, and reference records. Co-occurrence of keywords and author analyses were performed and visualized utilizing VOSviewer (version 1.6.16). The VOSviewer application can display Network Visualization, Overlay Visualization, and Density Visualization. Based on the visualizations, various information, such as overflow research, limited research, and previous research, was presented. VOSviewer also provides information on clusters of keywords.

DISCUSSION

Summary of yearly published and Citations

The beginning search of publications from the Scopus database for ten years, 2013 to 2023, was obtained from 170 articles. According to the content, there are 145 adequate articles. Based on these results over the past decade, the yearly publication and citation counts of articles on endophytic actinomycetes have fluctuating peaks (fig.1). Culminate at 20 and 550 consecutively in 2013. Decrease to 14 and 238 in 2014, 16 and 177 in 2015, 16 and 297 in 2016, 15 and 219 in 2017, 8 and 97 in 2018, 9 and 258 in 2019, 11 and 80 in 2020, 14 and 46 in 2021, 12 and 60 in 2022, at last 9 and 9 in 2023. The full amount of articles and citations of saved publications from 2012 to 2021 were 125 and 2021,

respectively. The number of citations in a publication indicates the extent to which the work has captured researchers' interest and the potential for it to become a focal point of research over the past decade (Klykleung et al., et al. 2020)

Analysis of keyword co-occurrence

Keywords convey the central theme of a publication; I obtained 464 keywords from 145 screening articles. The analysis, facilitated by VOSviewer software, focused on 353 keywords with a frequency of 1 or more. All keywords were systematically grouped into 76 clusters. The investigation spans the last decade and identifies the top ten keywords: endophytic actinomycetes, 16S rRNA, Polyphasic Taxonomy, Streptomyces, Antimicrobial activity, Medicinal Plants, Antifungal, *Oriza sativa*, Plant growth Promoting, Indole-3-Acetic Acid. The study visually presents the interconnections between these keywords through a network visualization in Fig. 2a. Node size corresponds to keyword frequency, with larger nodes revealing higher occurrences. The distance between nodes shows a closer correlation between the associated terms. A condensed representation of the interconnectedness is evident in the proximity of nodes, where a shorter distance signifies a stronger correlation among the chosen terms.(Anumudu et al. 2022).

In the context of bibliometric analysis, keywords were the main goal to measure scholarly literature's impact, distribution, and patterns. So, the function of keywords becomes crucial. The temporal evolution of keywords is visually represented in Fig 2b. Keywords highlighted in blue signify an earlier average year of publication, while those in green indicate consistent usage throughout the study period. Keywords in light green or yellow highlight represent newly emerging research areas. The most numerous publications are shown with bright color, and fewer publications are indicated by a dim color in density visualization (fig.2c). From 2013 to 2023, the focus of studies on endophytic actinomycetes In the past decade has involved the interaction of actinomycetes and host plants, previously unexplored. Researchers have focused on exploring their potential, studying the bioactive compounds they produce, and identifying newly discovered strains(Sun et al. 2022).

Publication sources

The top 5 journals published 81 papers on endophytic actinomycetes (2013-2023). International Journal of Systematic and Evolutionary Microbiology the first rank (48 papers), followed by Antonie van Leeuwenhoek, International Journal of General and Molecular Microbiology (16 papers), Journal of Antibiotics (10 papers), Journal of King

Saud University – Science (4 papers), Journal of Biotechnology (3 papers). The ranking of publications number was different from the number of citations. By citation Journal of Biological Inorganic Chemistry the most(312), World Journal of Microbiology and Biotechnology (102), Antonie van Leeuwenhoek, International Journal of General and Molecular Microbiology (89), World Journal of Microbiology and Biotechnology (80), Journal of Applied Microbiology (70).

Authors Contribution

The author's contribution and correlation among researchers can be identified in Fig.3; the most productive author is Liu Chongxi, who has 17 documents with a total correlation of 128 with other researchers. Followed by Xiang, Wencheng, who has 16 documents and 122 correlations. Next Wang, xizngjing (14,106), Zhao, Junwei (12, 90), Matsumoto,atsuko (11,62)**.** Tanasupawat,somboon (10,50), Duangmal, kannika (10,36), Pittayakhajonwut, pattama (9,45),Suriyachadkun,chanwit (9,39), Jiang, Ji-Hong (8,57)

Based On the Citation, the author published four papers on actinomycetes endophytic for ten years (2013-2023). R. Mingma (134 Citations) got the first rank, C. Li (67), S. Qin (59), N. Niemhom (30), N. Tedsree(8). Published three papers: K. Xing (56 citations), H. Rachniyom (48), N. Kuncharoen (37), N. Klykleung (18), S. Muangham(9), and P. Mau (8). Published two papers: L. Li (38 citations), J. Zhao (20), X. Li (19), M.S. Chen(8), A. Nammali (7), C. Peng(7), P. Veilumuthu (4), A. Ali (4), J.y. Zhang (2). The most contributed who got a high number of papers and citations.

Countries and institution

Based on all papers found from 2013 to 2023 (fig.4), China was the first Rank for Countries contribution, with 63 published papers. Next, Thailand (33 Published), India (22 published) , Japan (6 Published), Vietnam (8 Published). Institution published most of the papers, Northeast Agricultural University with 16 publications as the top productive institution, Kasetsart University (11publication), Chulalongkorn University (9 publications), and Jiangsu Normal University (6 Publications).

Picture

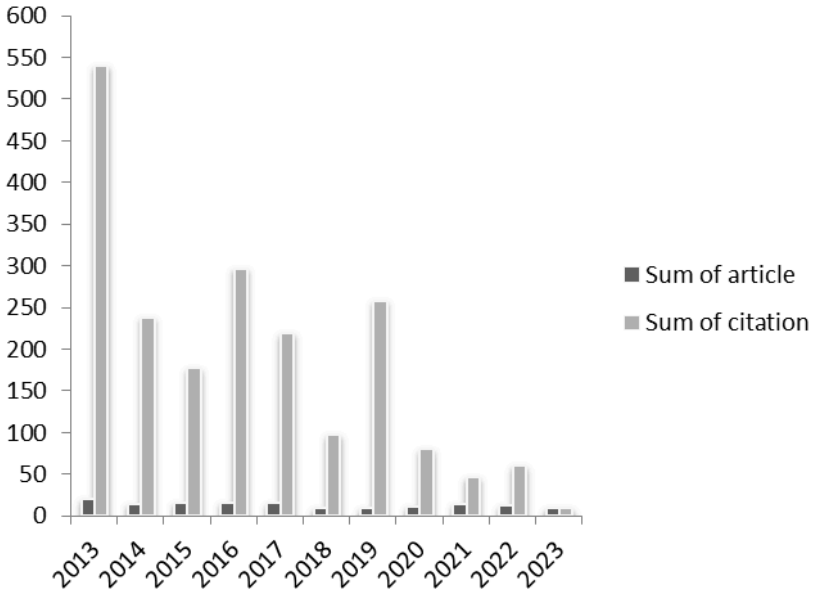

Fig. 1. Publication and citation on endophytic actinomycetes articles from 2013 to 2023

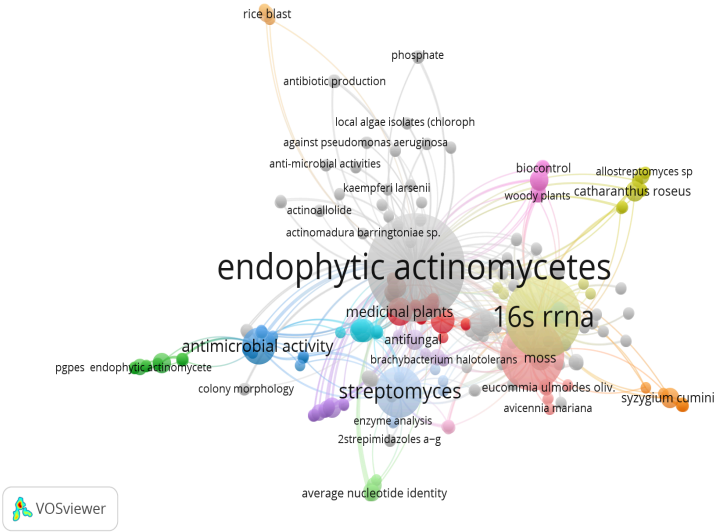

Fig.2a Network visualization of keyword co-occurrence.

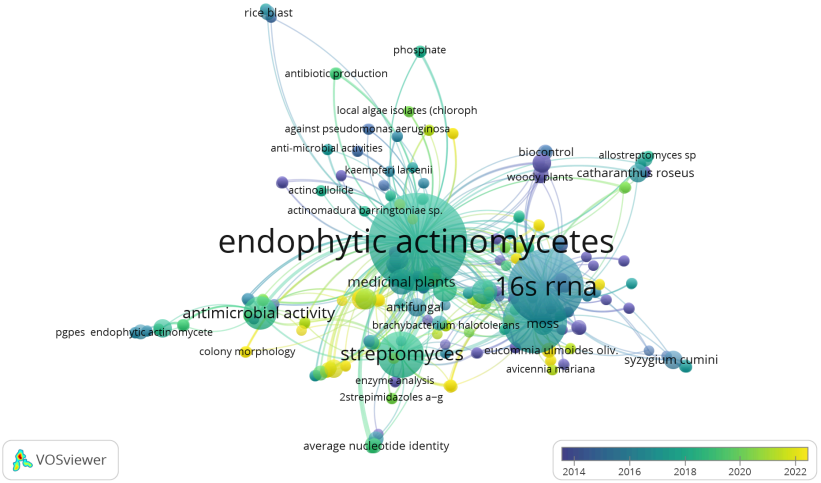

Fig.2b Overlay visualization of keyword co-occurrence.

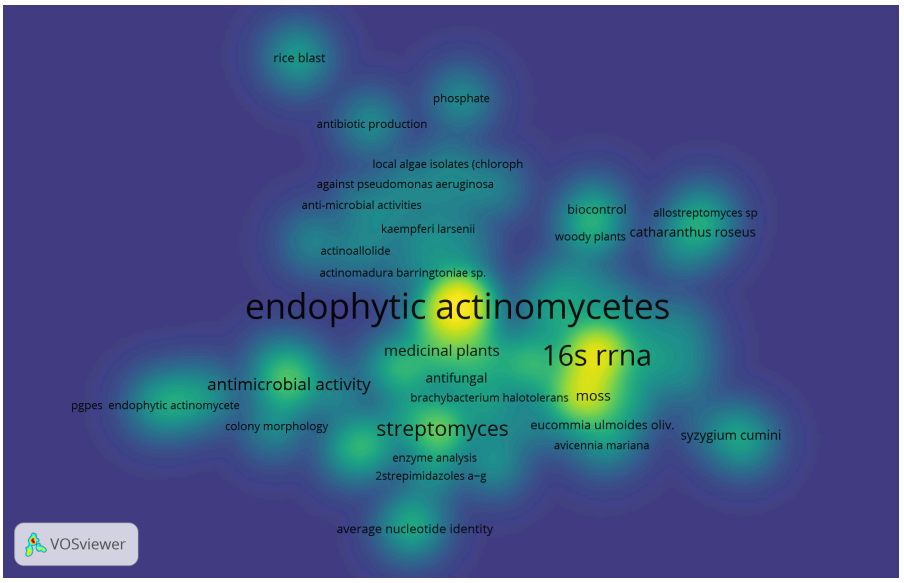

Fig.2c Dencity visualization of keyword co-occurrence.

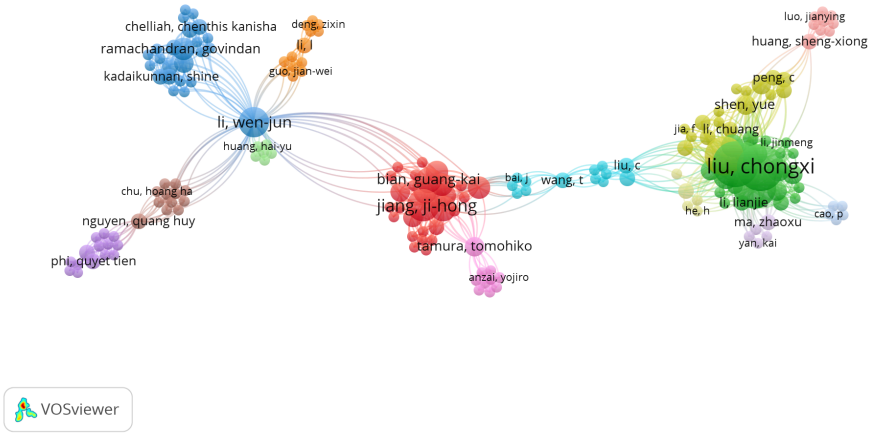

Fig.3. Network visualization of author co-authorship

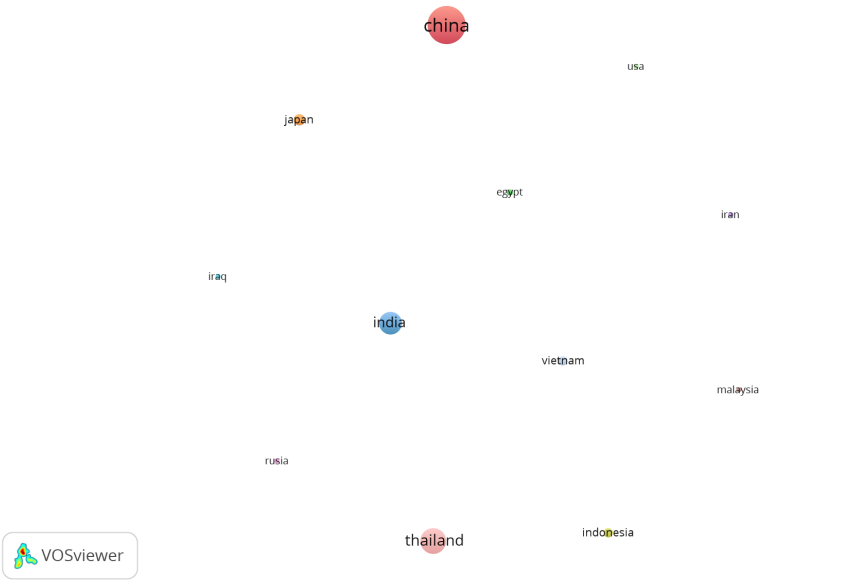

Fig.4. Network visualization of countries

CONCLUSION

Publications from the Scopus database ten years, publication and citation counts of articles on endophytic actinomycetes have fluctuated peaks. The first rank journal is the International Journal of Systematic and Evolutionary Microbiology. The most productive author is Liu. China is the first Rank for Countries' contribution, with 63 publications. The institution that published most of the papers was Northeast Agricultural University. For recommendations, it is necessary to conduct bibliometric analysis research on a more specific topic of bacterial potential over a certain period.

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