Trends in research publication topics related to eco enzymes with bibliometric analysis

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Abstract. Ecoenzyme is a potential sustainable waste management solution that could make waste management more beneficial. This study seeks to analyze the evolution of ecoenzyme-related research publication topic trends over the past decade, then visualize them and identify potential ecoenzyme-related research topics for future study. Using Publish or Perish software with Google Scholar database sources and VOSviewer software, this research method employs a literature review and bibliometric analysis. The investigation and search produced a collection of published document metadata regarding ecoenzymes that included up to 666 documents from 2013 to 2023. During that time, ecoenzyme-related research publications covered a variety of topics, including composition, training, and product development. N. Ginting and T. Wikaningrum are the authors who have contributed the most to the publication of the ecoenzyme topic, with a total of 12 publication documents. Further research can be conducted on the development of ecoenzymes, such as the investigation of the efficacy and effectiveness of using ecoenzymes and the investigation of other ecoenzyme research involving various other scientific disciplines. This study has limitations due to its reliance on data obtained through Google Scholar and its lack of a rigorous screening process. Therefore, it is recommended that future research take additional measures to filter more collected data.

1 Introduction

The technique of organic waste fermentation has garnered significant interest in recent times owing to its capacity for ecoenzyme production. Ecoenzymes refer to enzymes that are derived from the process of fermenting organic waste. These enzymes find utility in a range of applications, such as wastewater treatment, agriculture, and food processing

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[1]. The use of ecoenzymes derived from the fermentation of organic waste is in accordance with the Sustainable Development Goals (SDGs) established by the United Nations, specifically SDGs [2], which seek to promote sustainable consumption and production patterns [3, 4, 5]. Organic wastes, such as citrus fruit peels, vegetable trash, and food waste, have been utilized in the production of ecoenzymes [6, 7, 1]

Microorganism identification from fermented biowaste is critical for the synthesis of ecoenzymes. Microbial entities, namely bacteria and fungi, exert a substantial influence on the process of fermentation and have the capacity to generate a diverse array of enzymes, encompassing cellulases, amylases, and proteases [8]. The utilization of effective microorganisms (EMs) for the purpose of generating ecoenzymes from food waste has been the subject of investigation, and the findings indicate that the application of EMs can augment the production of ecoenzymes [7]. The utilization of food waste for the generation of ecoenzymes can also facilitate the mitigation of food waste and the advancement of a circular economy [6].

Due to the ability of ecoenzymes to degrade organic pollutants, they have been utilized in wastewater remediation. The utilization of ecoenzymes in the process of wastewater treatment is in accordance with Sustainable Development Goal 6 (SDG 6), which seeks to guarantee the accessibility and sustainable administration of water and sanitation for all [1]. Ecoenzymes made from vegetable and fruit waste have been employed in wastewater treatment, and the results have shown that they can successfully lower the chemical oxygen demand (COD) and biological oxygen demand (BOD) of wastewater [7]. Ecoenzymes can help treat wastewater while reducing the need for chemical treatments, which could have an adverse effect on the environment.

The utilization of ecoenzymes in specific applications has the potential to diminish dependence on chemical treatments and foster the adoption of sustainable practices. The generation of ecoenzymes through the process of fermenting organic waste has the potential to contribute to the mitigation of greenhouse gas emissions by decreasing the quantity of organic waste that is disposed of in landfills [6]. The objective of this paper is to perform a bibliometric analysis of ecoenzymes derived from the fermentation of organic waste and their application, with a particular focus on their relevance to the Sustainable Development Goals (SDGs). This paper aims to conduct a comprehensive examination of the existing body of research pertaining to the production, characterisation, and applications of ecoenzymes derived from the process of organic waste fermentation. Furthermore, it seeks to analyze the potential role of these ecoenzymes in fostering sustainable development.

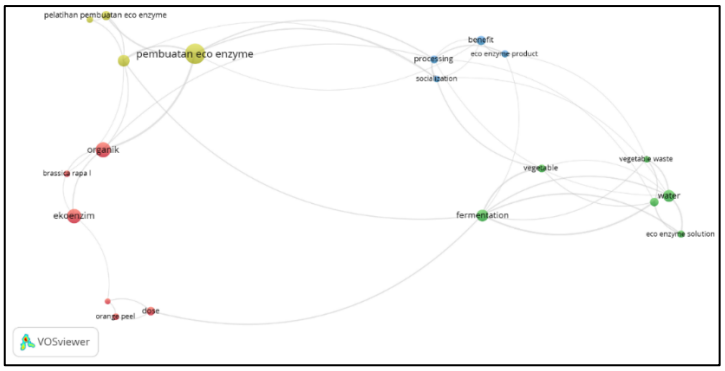
2 Methods

This research employs a systematic review methodology coupled with bibliometric analysis. The integration of these two approaches will provide a comprehensive analysis of the progression of scientific research both statistically, by employing bibliometrics, and qualitatively, through conducting systematic reviews on specific subjects and content [9]. Bibliometric analysis refers to a quantitative research approach that utilizes the Publish or Perish software in conjunction with the Google Scholar source database. The VOSViewer software was utilized to visualize the publishing trend mapping, with the

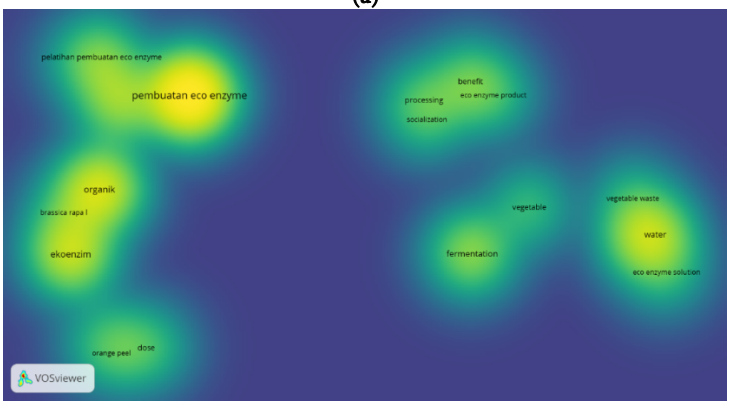
aim of assessing the extent to which publications have contributed to the advancement of knowledge across diverse literary sources. Bibliometric analysis enables the identification of novelty and trends in research [10]. The present study was conducted using an online search on September 13, 2023. A comprehensive web search was undertaken by researchers, wherein the terms 'Ecoenzyme', 'Eco-enzyme', and 'Eco enzyme' were entered in the title area, covering the period from 2013 to 2023.

3 Result and discussion

The findings of the interpretation analysis conducted using VOSViewer, utilizing publication data extracted from the Google Scholar database, yielded three distinct types of bibliometric mapping visualization. These include network visualization (figure 1a), overlay visualization (figure 1c), and density visualization (figure 1b). The occurrence of each term will be visually represented by a colored circle accompanied by a connecting line, which serves to illustrate the relationship between one keyword and another. There is a positive correlation between the size of a circle representing a term and the frequency of its occurrence in the abstract and title of the gathered publishing data [11].



(a)



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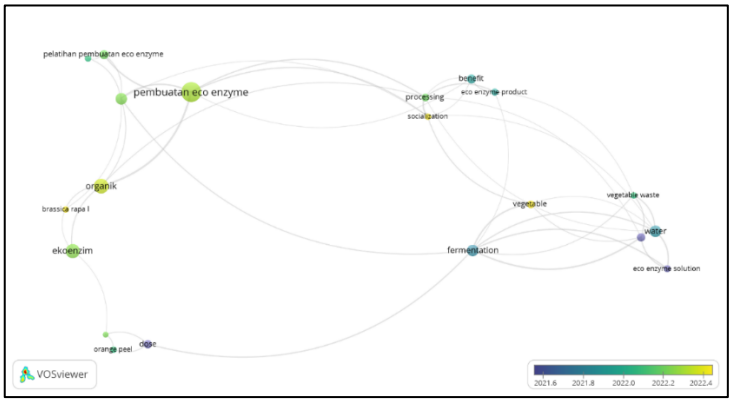


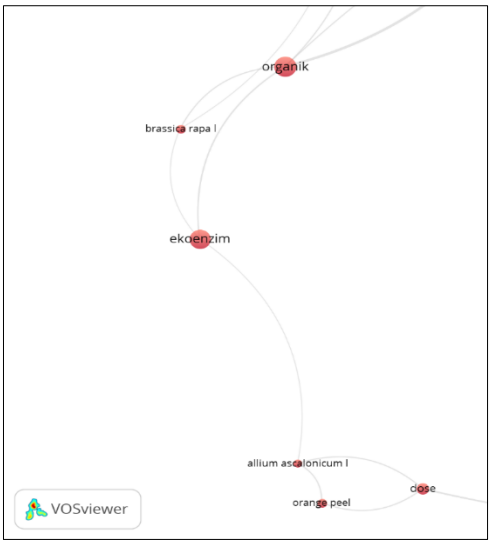
(c)

Fig. 1. Visualization results of bibliometric mapping **(a)** network, **(b)** density, and **(c)** overlay based on the collection of publication data for the last 10 years on the topic of ecoenzymes from the Google Scholar database.

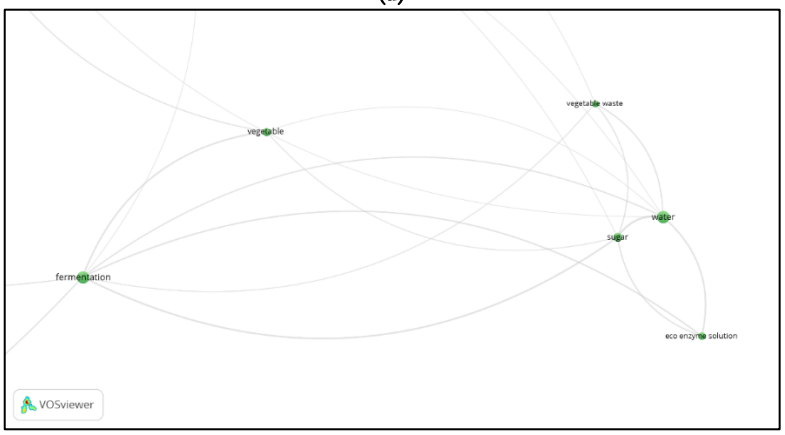
The ecoenzyme topic network visualization reveals that throughout the past decade, publications on ecoenzymes may be categorized into four distinct clusters (Figure 1a). Clusters are classified according to the overarching theme of the frequency of commonly occurring keywords. The initial cluster exhibits a red color and comprises specific keywords, including organic, ecoenzyme, dosage, orange peel, Allium ascalonicum L., and Brassica rapa L (Figure 2a). The cluster of articles identified by these six keywords mostly focuses on the discourse surrounding the production of ecoenzymes and the evaluation of ecoenzyme treatment methods. This includes investigations into the optimal dose levels and the utilization of organic materials in the ecoenzyme manufacturing process. In their study, [12] demonstrated that the ecoenzyme derived from orange peel waste (Citrus sp.) cage cleaning solution possesses inhibitory properties against the growth of Escherichia coli and Staphylococcus aureus. The findings demonstrate that ecoenzymes derived from orange peel waste exhibit a bactericidal effect that is fivefold greater than that of detergent when applied to a standardized test area. Additionally, other studies demonstrate that the usage of ecoenzymes from orange, chicory, and pineapple peels can decrease the dry weight of shallot bulbs (Allium ascalonicum L.) by 18.41, 37.78, and 26.29%, respectively [13]. These two papers represent a subset of the several forms of publications that pertain to similar issues within this cluster, which focuses on development trends seen over the past decade.

As shown in figure 2b, the second cluster is colored green. The cluster encompasses the following keywords: fermentation, vegetable, vegetable waste, water, sugar, and ecoenzyme solution. The keywords present in this cluster suggest that the publications within this cluster primarily focus on the examination of processes related to ecoenzymes. These processes encompass various aspects, including the composition of ecoenzymes and the fermentation process involved in the production of ecoenzyme solutions. The research conducted by [14] demonstrates alterations in both color and volume observed during the organoleptic evaluation of the ecoenzyme solution under investigation. The observed variation might be attributed to disparities in water content within the organic waste utilized, as well as the duration of the fermentation process involved in the

production of ecoenzymes, culminating in the formation of the final ecoenzyme product. The findings presented in this publication represent a specific type of scholarly output that pertains to a similar subject matter within the second cluster category throughout the past decade



(a)



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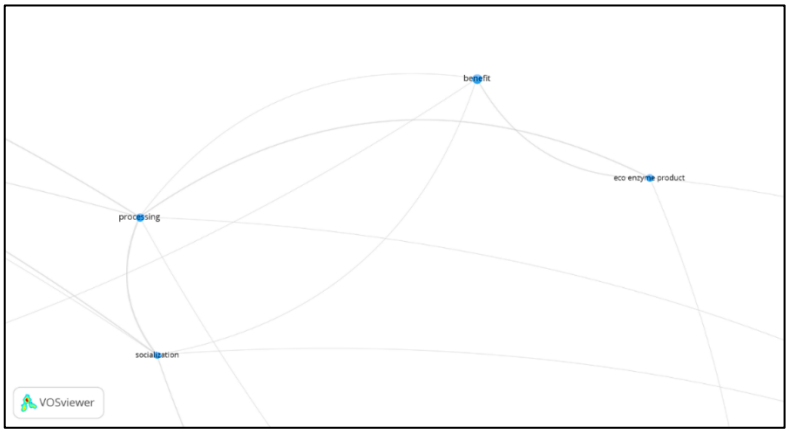

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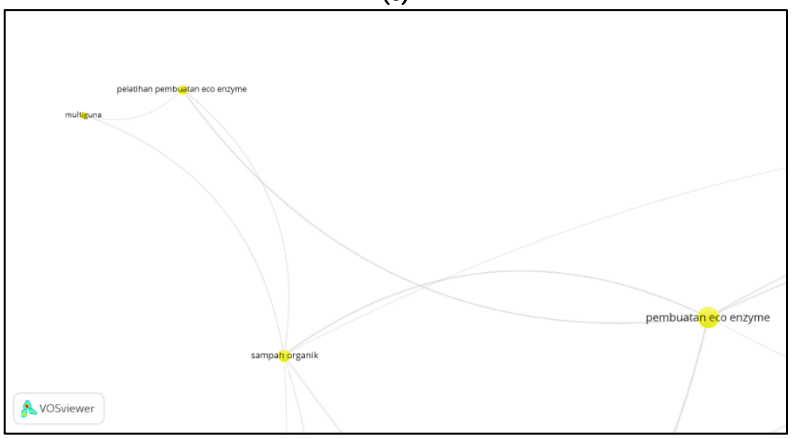

(d)

Fig. 2. Keyword members in **(a)** cluster 1, **(b)** cluster 2, **(c)** cluster 3, and **(d)** cluster 4 ecoenzyme publication topics

The classification of the next cluster is represented by the blue color in figure 2c. The cluster under consideration encompasses the keywords processing, benefit, socialization, and eco enzyme product. These keywords serve as indicators for the categorization of publications within this cluster, which predominantly focus on the analysis of the advantages and applications of ecoenzyme goods. In a recent study conducted by Wikaningrum and [15], it was observed that the utilization of eco enzymes at varying concentrations (0%, 2%, 4%, and 6%) over a period of 10 hours resulted in a corresponding decrease in nitrite levels by 0.3%, 20%, 29%, and 35% correspondingly. The application of greater concentrations, specifically 10%, 15%, and 20%, resulted in nitrite removal efficiencies of 35.7%, 36.7%, 46.7%, and 49.4% correspondingly after a 7-hour exposure period. The findings of these articles suggest that there exists a correlation between the topics covered in publications belonging to the third cluster category within the past decade.

The last cluster depicted in figure 2d is denoted by the color yellow. The members of this fourth cluster contain key terms such as the production of ecoenzymes, training in ecoenzyme production, organic waste management, and multipurpose applications.

Publications within this cluster mostly focus on the examination of endeavors aimed at fostering the development of ecoenzymes within the community, often through means like as training initiatives. [16] elucidated in their publication that conducting training and socialization programs on the utilization of vegetable and fruit waste for ecoenzyme production will enhance the community's capacity to repurpose trash into economically valuable products. In addition, it was emphasized that a crucial factor for the activity's success lies in fostering community knowledge regarding the need to adhere to health norms and comprehending the potential of the village. This understanding enables the conversion of trash into ecoenzyme products that possess versatility and offer numerous advantages. The subject matter under consideration has emerged as a prominent area of focus within the realm of scholarly publications over the past decade, falling within the purview of the fourth cluster type.

Figure 1b illustrates a density representation that showcases the hierarchical arrangement of themes mentioned, as determined by the frequency of keywords present. The intensity of the color of the keyword signifies the frequency of its occurrence or discussion within the article. According to the density mapping visualization, it is evident that the subject matter extensively addressed in ecoenzyme literature over the past ten years pertains to the production of ecoenzymes, particularly those that are closely associated with instruction and familiarization in ecoenzyme manufacturing (Figure 1a). The paper of [2] has demonstrated. Training activities were conducted to teach the production of ecoenzymes, which were subsequently applied with success in Karang Joang Village. The innovative approach to waste management and processing implemented by the individuals in question serves as a cost-saving alternative by offering educational programs and training on the production of disinfection liquid. In contrast, the overlay graphic presents a depiction of year-on-year patterns throughout the past decade pertaining to publications on ecoenzymes, utilizing frequently employed keywords. According to the data presented in Figure 1c, it can be observed that the term "making ecoenzymes" is frequently mentioned in scholarly papers throughout the approximate timeframe of 2022. The data presented in Figure 3 indicates a notable surge in the number of publications related to ecoenzymes in the year 2022, as compared to preceding years within the past decade. Specifically, there were 277 publications on this topic out of a total of 666 publications. The individuals who have made regular contributions to the authorship of ecoenzyme papers throughout the past decade include N. Ginting and T. Wikaningrum.

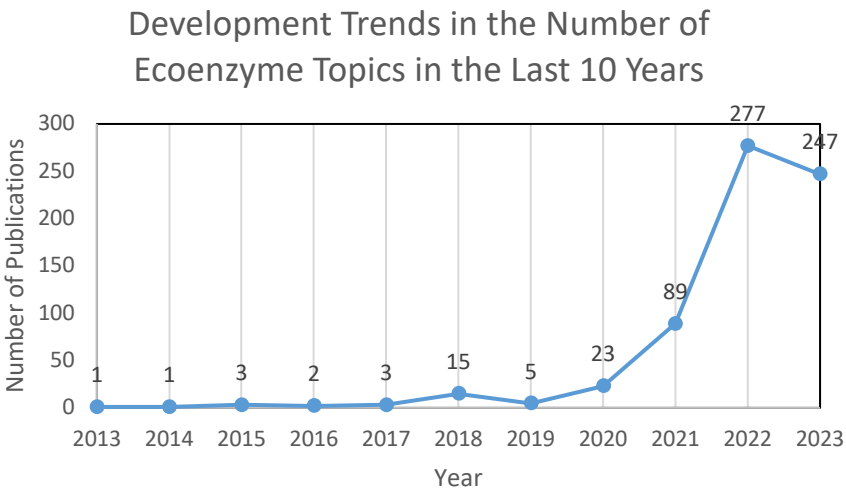

Fig. 3. Trend development in the number of ecoenzyme publications in the last decade

The analysis of keyword mapping for ecoenzyme publications over the past ten years reveals the recurrence of some subjects that serve as updates to the ongoing discourse on ecoenzymes. The scarcity of discussions pertaining to this topic within the field of ecoenzyme studies in past years highlights the need for further exploration and the acquisition of updated knowledge in this area. In addition, it is conceivable that the discourse on ecoenzymes will encompass novel areas of study, including investigations into the usefulness and effectiveness of ecoenzyme utilization, as well as explorations of ecoenzyme research within other scientific disciplines. The bioinformatics approach is a scientific methodology that can be employed for the advancement of ecoenzymes. The field of bioinformatics has experienced significant growth and has had a transformative impact on scientific advancements. The application of computational tools and methodologies is employed to evaluate and understand biological data. The application of bioinformatics has been observed across diverse domains, including genomics, proteomics, and metabolomics, wherein it facilitates the identification and analysis of biological molecules and their relationships. The application of bioinformatics has facilitated the advancement of novel pharmaceuticals, immunizations, and diagnostic instruments [17, 18]. Bibliometrics has an important contribution in research [19-23]. The novelty and importance of further research can be obtained from bibliometric analysis [24-28]. Furthermore, this technique has been employed for investigating the evolutionary processes of biological systems and elucidating the intricate characteristics and functionalities of proteins, such as the enzyme found in ecoenzymes.

4 Conclusion

Based on bibliometric evaluation of the growth of ecoenzyme trend publications. There remain numerous avenues for further advancement in the field of ecoenzyme research, including investigations into the efficacy and effectiveness of ecoenzyme utilization, as

well as the exploration of interdisciplinary approaches involving bioinformatics and other scientific disciplines. This can serve as a foundation for future advancements in ecoenzyme research

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