From taxonomy to biotechnology: a bibliometric review of global *Amorphophallus* research in the context of tropical bioresources (1912–2025)

Wida Salupi[1*], *Meliyana* Aini[1], *Luthfiana Nur* Tamara[2], and *Cecep* Suhardedi[3]

[1]Science Education Program, Faculty of Teacher Training and Education Lambung Mangkurat University, Banjarmasin, South Kalimantan, 70124, Indonesia
[2]Biology Education Program, Faculty of Teacher Training and Education Lambung Mangkurat University, Banjarmasin, South Kalimantan, 70124, Indonesia
[3]Study Programme of Agricultural Science, Faculty of Agriculture, Universitas Padjadjaran, Bandung, West Java, 45363, Indonesia

Abstract. The genus *Amorphophallus*, belonging to the family Araceae, is an important component of tropical bioresources. Over the past century, and especially within the last decade, *Amorphophallus* has attracted increasing scholarly attention because of its considerable ecological, economic, and biotechnological potential. This study aimed to assess global research productivity on *Amorphophallus* using a bibliometric approach, drawing on data retrieved from the Scopus database covering the period from 1912 to 2024. Bibliometric mapping and analysis were conducted using VOSviewer and Biblioshiny. The results revealed that Amorphophallus is significant in terms of taxonomy and ecology and holds substantial promise across multiple applied domains. These include sustainable agriculture, food security (with its tubers serving as alternative carbohydrate sources), pharmaceuticals (notably due to bioactive compounds such as glucomannan), biotechnology, cosmetics, and bio-based industries. Furthermore, the genus plays a growing role in biodiversity conservation and in support of resource-based economic development, particularly in the context of climate change and tropical land degradation. By providing a comprehensive visualization of the global research landscape on *Amorphophallus*, this study reconstructs its historical development and identifies emerging trends, while offering strategic insights to guide future research directions and the sustainable utilization of this genus as a valuable tropical bioresource through 2025 and beyond.

1 Introduction

The genus *Amorphophallus* is one of the Araceae family's taxonomic groups with a high level of morphological, taxonomic, and ecological diversity. This diversity includes variations in plant size, flower shape, leaf stalk pattern, appendix structure, and spathe

* Corresponding author: wida.salupi@ulm.ac.id

coloration, making it one of the most complex genera in Araceae [1]. To date, around 239 species have been identified, with an estimated potential of more than 300 species, widely distributed in the tropical and subtropical Paleotropics, with the center of diversity in Southeast Asia [2].

Important species such as *A. paeoniifolius* (elephant foot yam), *A. konjac, A. titanium, A. campanulatus,* and *A. muelleri* (porang) have been widely studied due to their economic value and potential applications. One of the main compounds of interest is glucomannan, a high molecular weight water-soluble polysaccharide stored in tubers. Glucomannan is known for its low glycemic index, high viscosity properties, and ability to reduce body weight and cholesterol, thus having strategic value in developing functional food and pharmaceutical products [3].

Along with the increasing need for sustainable biological resources, the genus *Amorphophallus* has become an important object in biotechnology research, especially in developing and utilizing konjac glucomannan (KGM). Glucomannan from A. konjac has unique physicochemical properties, such as the ability to form gels, water solubility, and is biocompatible and biodegradable, making it an ideal material in various biotechnology applications [4]. KGM is used as a thickening agent, gelling agent, and dietary fiber in the food and health sectors. The benefits of *Amorphophallus* plants in the food sector include analog rice, noodles, jelly, ice cream ingredients, and meatball mixes [5]. The industrial sector has materials for the cosmetic industry, pharmaceutical ingredients, and diet drugs. In the pharmaceutical sector, KGM is an excipient in tablet formulations, targeted drug carriers, and basic materials for controlled drug release systems [6]. In addition, research also shows the potential of glucomannan as a basic material in the manufacture of biodegradable films, nanocomposites, and encapsulation systems for the delivery of active ingredients [7]. Industrially, glucomannan is used to produce environmentally friendly adhesives, paints, textile coatings, and even as a substitute for cellulose-based materials such as photographic film and celluloid [8]. This expands the scope of *Amorphophallus* utilization in the industrial biotechnology sector, especially in the development of sustainable biomaterials.

Through a bibliometric approach, this study aimed to evaluate the productivity and dynamics of global research on *Amorphophallus* as an important element of tropical bioresources. The analysis was based on data from the Scopus database from 1912 to 2024. Bibliometric mapping was performed using VOSviewer and Biblioshiny software to trace research trends, collaboration patterns between authors and institutions, geographical distribution of publications, and thematic evolution in the scientific literature. This study also aims to identify the contribution of *Amorphophallus*, especially glucomannan, in the development of biotechnology innovations that support the food, health, and environmentally friendly industries sectors.

2 Methodology

2.1 Bibliometric analysis

The data presented in this article were retrieved from the Scopus database on May 06, 2025. Scopus was chosen because it is continuously updated and improved, making it one of the largest searchable databases of academic article abstracts and citations alongside Web of Science and Google Scholar [9]. In this study, the Scopus dataset from 1912 to 2025 was retrieved, and a total of 1405 documents were retrieved. All information extracted from Scopus has been stored as comma-separated value (.csv) and research information system (.ris) files. Figure 1 is a flowchart illustrating the search methodology. Our document selection was limited to peer-reviewed sources such as journal articles, conference proceedings, and book chapters to ensure the best quality and reliability.

Bibliometrics is defined as the use of mathematical and statistical methodologies in analyzing books and various forms of communication. Bibliometric analysis is a method used to examine the characteristics of books (or, in this study's context, to assess literature collections), operating based on bibliographic data. For example, literary compilations can be quantified [10]. Identifying characteristics that emerge from research can be achieved by classifying publications based on various criteria, such as year of publication, authorship, affiliation, or country of origin, as applicable. Various metrics, such as the number of citations, annual citation rate, h-index, and g-index, can be used to evaluate the impact and performance of publications. In addition, indicators such as co-authorship, co-citations, occurrence of keywords or concepts, and bibliographic integration can be used to map and display the current status of publications. The methodology of our search is comprehensively illustrated in Figure 1.

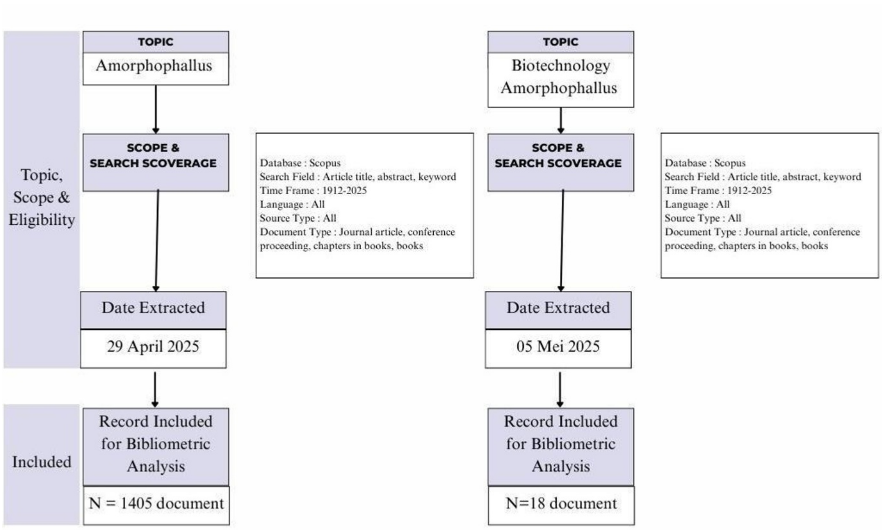

Fig. 1. Flow diagram of the search strategy.

2.2 Data analysis

The data presented in this article were taken from the Scopus database on April 29, 2025, with the keyword “*Amorphophallus*” and May 05, 2025, with the keyword “Biotechnology *Amorphophallus*”. A total of 1405 documents were retrieved using the following query: (TITLE-ABS-KEY (trust) AND TITLE-ABS-KEY (named AND data AND networking) OR TITLE-ABS-KEY (ndn)) for the keyword “*Amorphophallus*” and 18 documents from the keyword “Biotechnology *Amorphophallus*”. All information extracted from Scopus has been stored as comma-separated value (.csv) and research information system (.ris) files. Figure 1 is a flowchart illustrating the search methodology. The data obtained were used to create a visual representation depicting the increase in publications and cumulative citations of scientific articles. This study used VOSviewer software (version 1.6.17), Microsoft Excel, and Biblioshiny. The following section will present the analysis of the collected data and its alignment with the previously formulated research questions.

3 Results

A search in the Scopus database with the keyword "*Amorphophallus*" yielded 1405 scientific articles from 1912 to 2025. Figure 2 shows the number of scientific articles published by year. By viewing the documents by year of publication, we can see how the number of publications has grown. The highest productivity occurred in 2022, with a total of 174 documents. There was a general increase in the number of documents during the study period, with a slight decrease from 2012 to 2025. Figure 3 shows the country collaboration in research on *Amorphophallus*.

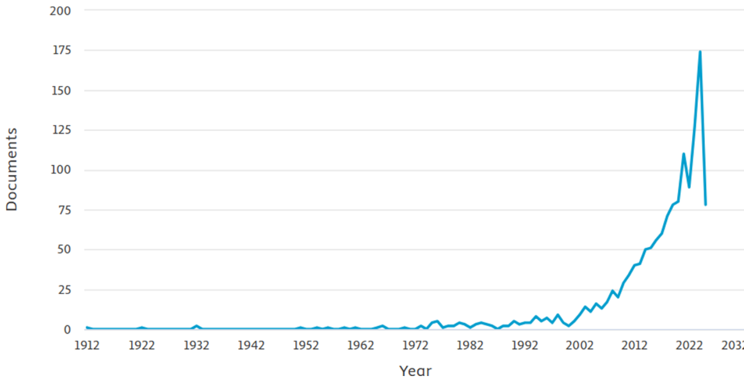

Fig. 2. Document by year.

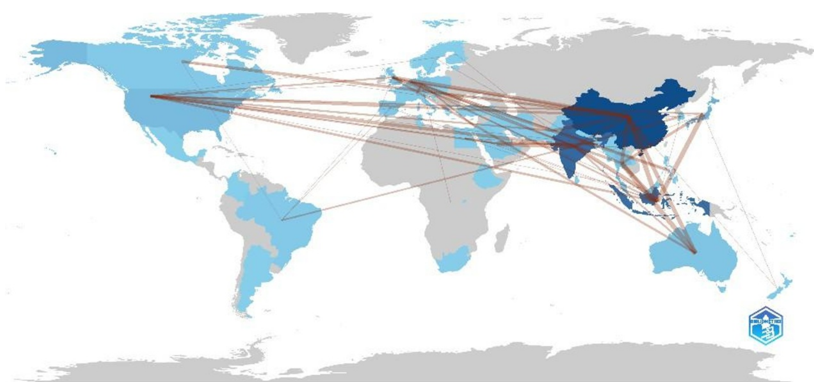

Fig. 3. Country collaboration map.

Figure 4 shows the number of scientific publications based on the country of origin of the corresponding author in the study of *Amorphophallus*, accompanied by the type of collaboration: SCP (Single Country Publications), an article whose authors are all from one country. MCP (Multiple Country Publications) is an article written by collaborators from several countries. Figure 5 shows productive and consistent authors in publishing works related to *Amorphophallus*, from 1912 to 2025.

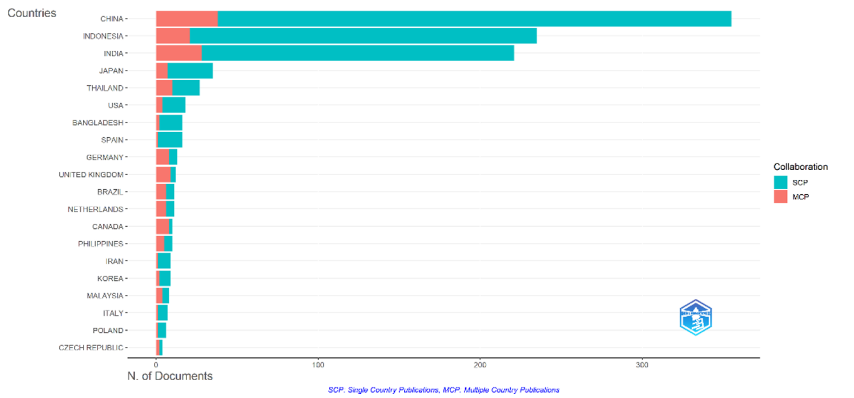

Fig. 4. Corresponding author’s countries.

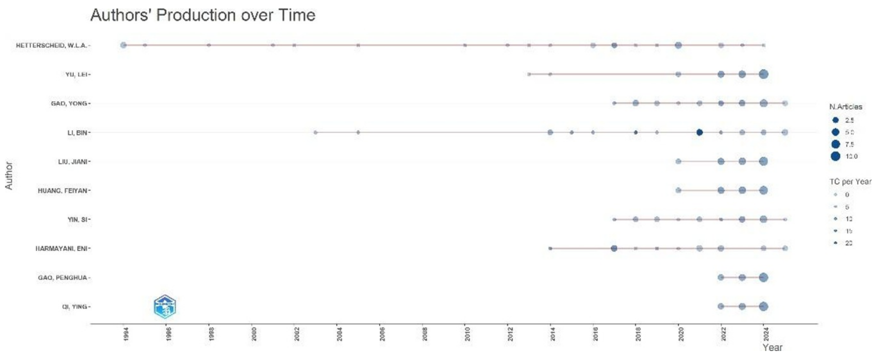

Fig. 5. Authors’ production over time.

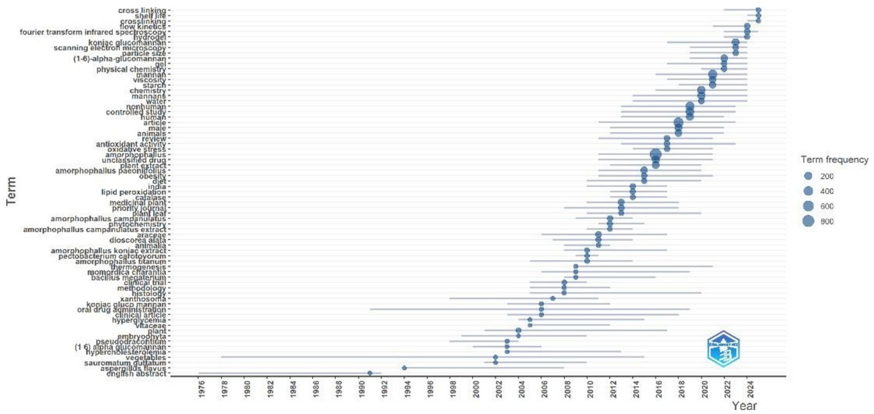

Fig. 6. Trend topic.

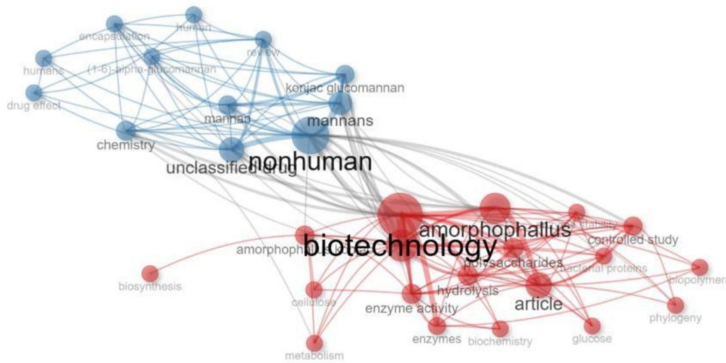

Fig. 7. Co-occurrence network.

Figure 6 illustrates the trend analysis of *Amorphophallus*-related studies from 1912 to 2025, displaying both the frequency and temporal distribution of the term's occurrence. The size of each circle in the graph reflects the intensity of keyword usage during specific time periods.

Figure 7 displays a Three-Field Plot that visualizes the relationship among three key bibliometric components in *Amorphophallus* research, particularly in the context of glucomannan studies. These components include CR (Cited References), which highlights the most influential scientific works; AU (Authors), representing prominent researchers in the field; and DE (Descriptors/Keywords), which summarizes the most frequently utilized terms in the literature.

A targeted search using the keyword 'Biotechnology *Amorphophallus*' resulted in the identification of 18 relevant documents. The historical development and distribution of these publications are presented in Table 1.

Table 1. Historiograph_Network_bibliometrix

Paper	Title	Author_Keywords	DOI	Year	LCS	GCS
Zhang M, 2009, Appl Microbiol Biotechnol	Purification And Functional Characterization Of Endo-B-Mannanase Man5 And Its Application In Oligosaccharide Production From Konjac Flour	Bacillus Sp. Msj-5; Endo-Beta-Mannanase; Konjac Flour; Man5; Oligosaccharides Preparation	10.1007/S00253-009-1920-0	2009	1	51
Adachi O, 2020, Biosci Biotechnol Biochem	Taro Koji Of *Amorphophallus* Konjac Enabling Hydrolysis Of Konjac Polysaccharides To Various Biotechnological Interest	*Amorphophallus* Konjac; Aspergillus Luchuensis; Glucomannan; Konjac Taro Koji	10.1080/09168451.2020.1787812		0	2
Zhu F,2018, Food Chem	Modifications Of Konjac Glucomannan For Diverse Applications	Biodegradable; Chemical And Physical Modifications; Encapsulation; Film; Konjac	10.1016/J.Foodchem.2018.02.151		1	139

		Glucomannan; Super Absorbent; Underutilized Species				
Devaraj Rd, 2019, Int J Biol Macromol	Health-Promoting Effects Of Konjac Glucomannan And Its Practical Applications: A Critical Review	Applications; Health Benefits; Konjac Glucomannan; Soluble Dietary Fiber	10.1016/J.Ijbiomac.2018.12.203		0	241

Figure 8 is a keyword co-occurrence network of scientific publications related to *Amorphophallus* and Biotechnology, visualized using bibliometric software such as VOSviewer. Red and Blue indicate two main clusters in the literature: The red cluster focuses on biotechnology and applied sciences, and the blue cluster focuses on chemical, medical, and nutritional aspects.

Fig. 8. WordCloud.

Figure 8 is an interpretation of the wordcloud. The font size shows the frequency of keywords' occurrence in the analyzed documents. The larger a word, the more often it appears in research and publications. The colors here do not reflect a particular category, they are just for an interesting visualization.

4 Discussion

The genus *Amorphophallus* has around 176 species spread worldwide, 25 species or around 14.2% of which are found in Indonesia. Of the 25 species found in Indonesia, 18 species (72%) are endemic, namely eight species in Sumatra, six species in Java, three species in Kalimantan, and one species in Sulawesi [1]. Through a bibliometric approach, the visualization of Authors' Production over Time (Figure 5) records the dynamics of authors' contributions to this study. It reflects how scientific attention to *Amorphophallus* has changed over time. *Amorphophallus* has developed in response to the urgency of sustainable use of tropical resources.

4.1 The growth of *Amorphophallus* scientific work

Based on Figure 5, the number of publications related to *Amorphophallus* has significantly increased since 2012, with the highest peak in 2022. This trend reflects the increasing global scientific awareness of the potential and challenges of utilizing *Amorphophallus*, especially as a tropical endemic plant that plays an important role in providing alternative food and health solutions through fiber content such as glucomannan [11].

Countries such as China and India are at the center of *Amorphophallus* research progress (Figure 3), with high collaboration intensity, indicated by the thickness of the connection lines between countries. Both countries have long utilized *Amorphophallus* as a food and traditional medicine, and now dominate research related to glucomannan, phytochemistry, and ethnopharmaceuticals [12]. In Southeast Asia, Indonesia, Thailand, and Malaysia have made important contributions, along with the natural distribution of *Amorphophallus*. Indonesia, with more than 30 endemic species, is a key country in conserving and developing alternative foods [13]. Countries such as Germany, England, France, the United States, and Australia actively collaborate with Asian countries. Based on Figure 4, China, Indonesia, and India occupy strategic positions in the global research map related to *Amorphophallus* and glucomannan. Indonesia's position as a megabiodiversity country with a high level of international collaboration emphasizes its important role in the tropical research agenda. The increasing number of cross-country collaborative publications (Multiple Country Publications/MCP) also indicates that using *Amorphophallus* has become a global scientific issue [14].

4.2 Key author contributions in tropical context

Authors' contributions to *Amorphophallus* studies show a strong drive to develop innovations based on local biodiversity. Authors such as Hetterscheid, W.L.A., who has been active since 1994, are early figures in developing *Amorphophallus* taxonomy and domestication (Figure 5).

Since 2015, scientific production has increased sharply, with the most significant spike in 2020–2024. Authors such as Li, Bin; Yu, Lei; and Qi, Ying have shown active roles in developing biotechnological applications and food utilization of this tropical species. The high citation rate of publications by Li, Bin, and Gao, Penghua, shows their contributions' practical and academic relevance, especially in the conservation, cultivation, and optimization of *Amorphophallus* utilization.

The size and color of the circles in Figure 5 reflect the number of articles (N. Articles) and the number of citations per year (TC per Year). The large dark circles appearing on the names of Li, Bin, and Gao, Yong indicate high scientific influence. Their articles most likely focus on enzymatic engineering, quality improvement of glucomannan products, or environmentally friendly extraction methods, as described by [21, 22].

4.3 Topic trends *Amorphophallus*

Based on Figure 6, the keyword trends of *Amorphophallus* show thematic dynamics that develop over time. The horizontal line depicts the range of term occurrences, while the size of the circle reflects the frequency of its use. Terms such as "konjac glucomannan" and "(1–6)-alpha-glucomannan" dominate the keyword map, confirming the position of glucomannan as the primary focus in *Amorphophallus* research. The emergence of terms such as "*Amorphophallus* paeoniifolius" indicates an increasing interest in non-konjac species as sources of bioactive compounds. The trend of new terms that emerged in the period 2020–2025, such as cross-linking, flow kinetics, Fourier transform infrared spectroscopy, and scanning electron microscopy, reflects the shift in research direction towards a multidisciplinary approach. This marks the integration of nanotechnology, advanced characterization techniques, and clinical trials in food technology and pharmaceuticals. Thus, *Amorphophallus* research has evolved from taxonomic and ethnobotanical studies to research based on biotechnology, pharmacy, and materials engineering.

4.4 *Amorphophallus* biotechnology

Further bibliometric analysis using the keyword "*Amorphophallus* Biotechnology" yielded 18 documents in the Scopus database. The historiography presented in Table 1 helps trace the evolution of research themes, identify articles, and formulate future study directions, such as developing fermentation technology or glucomannan-based biomaterial innovation. Devaraj RD's (2019) article has the highest Global Citation Score (GCS) (241). It is an important review of the health benefits of konjac glucomannan in cholesterol control, blood glucose regulation, and the role of soluble fiber. Another article by [23] discusses the modification of glucomannan for cross-disciplinary applications, including biodegradable films, drug encapsulation, and superabsorbent materials, with a high GCS (139), indicating its significance in the fields of food, pharmaceuticals, and biomaterials.

Figure 7 shows the keyword co-occurrence network map, which groups two leading research focuses: (1) chemical-pharmaceutical, covering the study of active compounds and their applications in health, and (2) applied biotechnology, covering the processing of *Amorphophallus* biomolecules using enzymes and microorganisms to produce industrial products such as enzymes and biopolymers. Figure 8, a word cloud, illustrates that *Amorphophallus* research is multidisciplinary, covering microbial biotechnology, natural compounds, enzymology, pharmacology, taxonomy, and genomics. The presence of the word "biotechnology" as the most prominent keyword strengthens the position of *Amorphophallus* as a tropical resource with great potential for the development of innovative biotechnology.

5 Conclusions

The results of the bibliometric analysis indicate that *Amorphophallus* is one of the tropical biological resources with strategic potential in the development of sustainable biotechnology and bioindustry. The significant increase in publications since 2012 reflects the high global attention to the use of glucomannan, especially in functional food, pharmaceuticals, and biological materials. China, India, and Indonesia are the countries with the most significant contributions to this research, which aligns with the natural distribution and traditional use of *Amorphophallus*. The development of research topics that initially focused on taxonomy and ethnobotany has now shifted towards technological innovation, strengthening the position of *Amorphophallus* as a tropical commodity that supports the circular economy and future biosecurity.

References

1. C. Claudel, J. Soule, M. Chartier. Morphological diversity and reproductive traits in Amorphophallus: Taxonomic implications. Botanical Journal of the Linnean Society, **183**(3), 365–377 (2017).

2. P.C. Boyce, A. Kroesia. Studies on Amorphophallus (Araceae) of Southeast Asia. Gardens' Bulletin Singapore, **63**(1), 191–220 (2011).
3. B. Behera, R.C. Ray. Bioprocessing of Amorphophallus paeoniifolius: A potential functional food crop. Food Bioscience, **16**, 60–67 (2016).
4. L.H. Ho, N.A. Abdul Aziz, B. Azahari et al. Chemical composition and health-promoting properties of konjac glucomannan. Journal of Functional Foods, **35**, 491–502. (2017).
5. C. Suhardedi, W. Salupi, M. Aini. Utilization of porang glucomannan in local functional food products. Jurnal Teknologi Agroindustri, **10**(2), 99–108 (2023).
6. K.M. Zia, S. Tabasum, T.T. Butt, et al. Recent developments and future prospects on konjac glucomannan-based materials: A review. International Journal of Biological Macromolecules, **88**, 361–377 (2016).
7. X.Yang, Y. He, Y. Wang. Extraction, characterization, and bioactivities of glucomannan from Amorphophallus species: A review. Carbohydrate Polymers, **174**, 291–303 (2017).
8. S. Ganjari. Konjac glucomannan: A comprehensive review of chemical structure and applications. Journal of Applied Polymer Science, **131**(12), 40439 (2014).
9. L.Mora, R. Bolici, M. Deakin. The first two decades of smart-city research: A bibliometric analysis. *Journal of Urban Technology*, ***24***(1), 3-27 (2017).
10. https://doi.org/10.1080/10630732.2017.1285123
11. Pritchard, Alan. "Statistical bibliography or bibliometrics." Journal of documentation **25**: 348 (1969).
12. R.Mata, A. Nishida, C. Sales-Campos. Underutilized edible forest species in tropical rainforests: Role in sustainable diets and food security. Journal of Ethnobiology and Ethnomedicine, **19**(1), 15 (2023).
13. R. Chitra, A. Singh, P. Thomas. Ethnopharmacological value of glucomannan-based plants: A cross-cultural assessment. Journal of Ethnopharmacology, **285**, 114894 (2022).
14. T. Suhartati, M.R. Ramadhan, D. Hastuti. Biodiversity and conservation status of porang (Amorphophallus muelleri) in Indonesia. Biodiversitas, **22**(6), 2999–3007 (2021).
15. M.A. Koseoglu. Mapping the institutional collaboration network of strategic management research: 1980–2014. Scientometrics, **109**(1), 203–226 (2016).