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Pharmacological Potential and Bioactivity of Pandanus spp.: A Scopus-Based Bibliometric Analysis

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ABSTRACT

Introduction: Pandanus spp. are tropical plants widely recognized for their ethnomedicinal use and diverse phytochemical constituents, including flavonoids, alkaloids, and phenolic compounds with pharmacological potential. Despite this, global research on Pandanus remains fragmented and lacks systematic mapping.
Objective: This study aimed to perform a bibliometric analysis of Pandanus research related to pharmacological potential and bioactivity using Scopus-indexed literature.
Method: A Scopus search was conducted using taxonomic and pharmacological keywords without time restrictions, limited to English-language articles, reviews, and conference papers. Eligible records were analyzed with Bibliometrix (Biblioshiny) for bibliometric indicators and VOSviewer for visualization. Metrics included publication trends, citations, authorship, institutional and country contributions, co-citation networks, and keyword co-occurrence.
Conclusion: Between 1984–2024, publications exhibited steady growth, with early studies maintaining citation relevance for decades. Productivity was concentrated among a few authors, notably Nonato MG, supported by institutions such as Universiti Malaysia Terengganu and other Southeast Asian universities. Collaboration networks were primarily Asia-centered, with Indonesia and India as key hubs. Keyword mapping revealed four thematic clusters: phytochemistry and antioxidants, taxonomy and isolation, pharmacology and metabolism, and ethnomedicine. The Journal of Ethnopharmacology emerged as the primary publication outlet. Pandanus research reflects sustained interest, regional leadership, and thematic diversity. Broader international collaborations and advanced pharmacological investigations are essential to fully realize the therapeutic promise of Pandanus-derived compounds.

Keyword : *bibliometric analysis, bioactivity, pandanus spp., pharmacological potential, scopus database*

Introduction

Medicinal plants have long been recognized as indispensable sources of novel bioactive compounds, contributing significantly to drug discovery and the development of therapeutic agents (Ghous et al., 2023). With the global resurgence of interest in natural products, researchers are increasingly turning to plant-derived phytochemicals for their diverse pharmacological properties and potential roles in managing chronic and infectious diseases (Alam et al., 2020).

Within this context, the genus Pandanus (family Pandanaceae) comprises more than 700 species distributed across tropical and subtropical regions, particularly in Southeast Asia, the Pacific islands, and parts of Africa and Australia (Khizar et al., 2019). Several Pandanus species, such as Pandanus amaryllifolius, Pandanus tectorius, and Pandanus odoratissimus, hold cultural, culinary, and medicinal significance (Emmanuel et al., 2022). Traditionally, Pandanus leaves, roots, and fruits have been used for flavoring, dyeing, and in folk medicine to treat ailments ranging from headaches and skin infections to metabolic disorders (Jomehpour et al., 2019).

Phytochemical investigations have revealed that Pandanus spp. are rich in bioactive constituents including flavonoids, alkaloids, phenolic acids, lignans, and essential oils (Pratama et al., 2021). These compounds have been associated with antioxidant, antimicrobial, anti-inflammatory, antidiabetic, and cytotoxic activities, among others (Pratama et al., 2021). While numerous experimental studies have reported the pharmacological potential of Pandanus, the body of literature remains dispersed across journals, countries, and research disciplines, limiting the ability to identify dominant research themes and collaborative trends (Jimtaisong & Krisdaphong, 2016).

Bibliometric analysis offers a systematic approach to address this gap by applying quantitative and visualization techniques to map the intellectual structure, influential contributors, and thematic evolution of a research field (Wahyuni et al., 2024). The Scopus database, with its broad multidisciplinary coverage and rigorous indexing standards, serves as a robust platform for such an assessment (Castillo et al., 2023).

Therefore, this study aims to perform a comprehensive bibliometric analysis of Scopus-indexed literature on the pharmacological potential and bioactivity of Pandanus spp., evaluating publication and citation trends, leading authors, institutions, and countries, as well as journal impact, international collaborations, and thematic research clusters. By doing so, this work provides an evidence-based overview that can guide future research directions, foster collaborative networks, and enhance the translation of Pandanus-derived bioactives into pharmaceutical applications.

Objective

The objective of this study is to conduct a bibliometric analysis of scientific publications related to the pharmacological potential and biological activities of Pandanus spp. using the Scopus database. Specifically, the study aims to analyze publication and citation trends in this field, identify the main contributing journals, authors, affiliations, and countries, and visualize keyword co-occurrence maps of related publications using VOSviewer.

Methods

This study employed a quantitative bibliometric design to systematically map and evaluate the global research landscape on Pandanus spp. with a focus on pharmacological

potential and bioactivity. The research was conducted entirely in a digital environment, utilizing the Scopus database as the primary data source due to its comprehensive coverage of multidisciplinary, peer-reviewed literature. The analysis was performed between March and May 2024 under controlled conditions to ensure reproducibility and data integrity.

The study population comprised all Pandanus-related publications indexed in Scopus that addressed pharmacology, bioactivity, ethnomedicinal use, or phytochemistry. Inclusion criteria required that records be published in English as articles, reviews, or conference papers, and contain complete bibliographic metadata. Exclusion criteria applied to studies unrelated to pharmacological or bioactive aspects, publications in non-English languages, and records lacking essential bibliographic fields for analysis.

From this population, a purposive sampling approach was applied, capturing all eligible records without time restriction to reflect the complete historical trajectory of Pandanus research. The final sample included all documents meeting the inclusion criteria, ensuring comprehensive representation of the field across disciplines, regions, and publication years.

Data were retrieved using a structured search query combining taxonomic terms ("Pandanus" OR "Pandanus spp." OR "Pandanus amaryllifolius" OR "Pandanus tectorius" OR "Pandanus odoratissimus") with keywords related to pharmacology, bioactivity, ethnopharmacology, and phytochemistry. The bibliographic records were exported from Scopus in BibTeX and CSV formats for subsequent analysis. Extracted variables included author names, institutional affiliations, publication year, title, abstract, keywords, source title, citation counts, and Digital Object Identifiers (DOIs). Data cleaning was performed to standardize author names, affiliations, and keyword terms, ensuring accuracy in metric calculation and network mapping.

Data collection was conducted through the Scopus interface, adhering to predefined search and eligibility criteria. The bibliometric analysis was performed using the Bibliometrix R-package via the Biblioshiny web application to compute descriptive indicators such as annual scientific production, citation trends, most prolific authors, institutions, and countries. Network visualizations including co-authorship, co-citation, and keyword co-occurrence maps were generated using VOSviewer (version 1.6.20).

In the visualizations, node size represented the frequency of publications or citations, link thickness reflected the strength of collaboration or co-occurrence, and colors denoted thematic clusters. This combined approach allowed for both quantitative assessment and graphical representation of the intellectual structure, collaboration patterns, and thematic evolution of Pandanus research.

Results

Publication Trends and Citation Relevance

The temporal analysis of *Pandanus* spp. research revealed an early emergence of publications in 1984, 1992, and 1996, each contributing one article with citation windows of 42, 34, and 30 years, respectively. Subsequent years showed a gradual increase in output, with 1998 and 1999 each recording three publications, and the highest annual production within this early phase occurring in 2003 with five publications. Citation relevance remained notable for older studies, reflecting their long-standing influence in the field (Table 1).

Table 1. Distribution of publications and corresponding citable years (1984–2004) in *Pandanus* spp. pharmacological and bioactivity research.

Year	Articles	Citable Years
1984	1	42
1992	1	34
1996	1	30
1998	3	28
1999	3	27
2000	1	26
2001	2	25
2002	1	24
2003	5	23
2004	2	22

Most Relevant Authors

Author productivity analysis identified Nonato MG as the most prolific contributor, with 13 publications, underscoring a substantial role in advancing the field. Kitajima M, Takayama H, and Tan MA followed with nine publications each, while Andriani Y contributed eight publications. Other significant contributors included Aimi N, Sung YY, and Zhang X with five publications each, and Amir H and Chang F-R with four publications each (Figure 1).

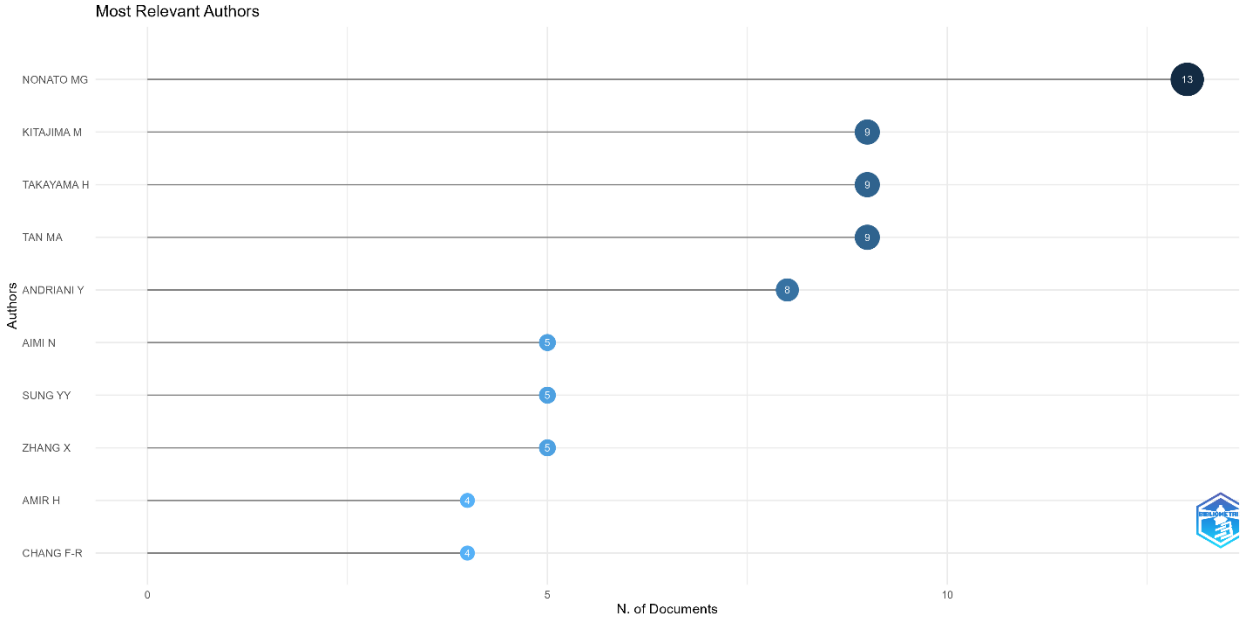

Figure 1. Distribution of the most relevant authors based on the number of publications, with Nonato MG leading, followed by key contributors from Japan, Malaysia, and the Philippines.

Institutional Contributions

Analysis of institutional affiliations revealed that Universiti Malaysia Terengganu was the leading institution with 61 publications, followed by Universiti Putra Malaysia (28 publications). Chiang Mai University and the University of Santo Tomas each contributed 25 publications, while Universiti Teknologi MARA recorded 23. Additional active institutions included Chiba University (21), Hasanuddin University (20), Prince of Songkla University (18), Universitas Nasional (18), and

Kaohsiung Medical University (17), indicating strong regional productivity within Southeast Asia (Figure 2).

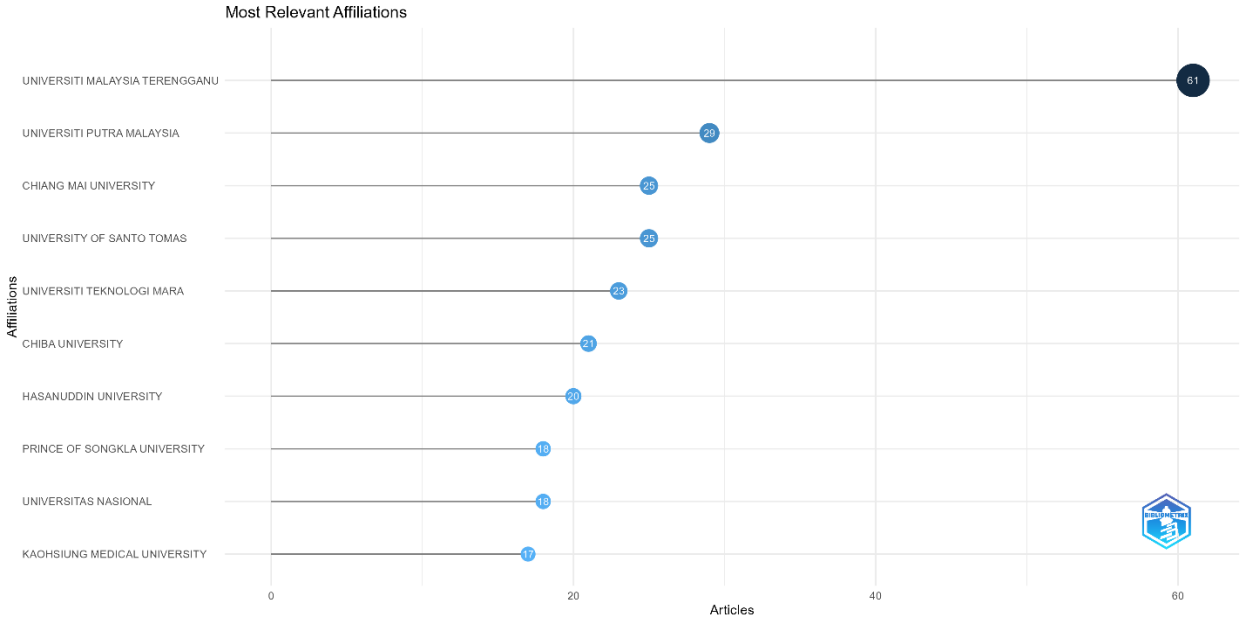

Figure 2. Top 10 institutions ranked by the number of publications in *Pandanus* spp. pharmacology and bioactivity research.

Most Cited Publications

Citation analysis showed that the most influential paper was authored by Patel DK (2012) in *Asian Pacific Journal of Tropical Biomedicine*, with 604 total citations and an average of 43.14 citations per year. Hussain A (2019) in *RSC Advances* ranked second with 215 citations and a high annual citation rate of 30.71. Abe R (2013) in *Journal of Ethnopharmacology* followed with 175 citations, while Abas F (2006) in *Food Chemistry* and Jain A (2005) in *Journal of Ethnopharmacology* recorded 172 and 153 citations, respectively (Table 2).

Tabel 2. Top five most cited publications on *Pandanus* spp. research.

Paper	DOI	Total Citations	TC per Year
Patel Dk, 2012, Asian Pac J Trop Biomed	10.1016/S2221-1691(12)60032-X	604	43.14
Hussain A, 2019, Rsc Adv	10.1039/c9ra01659g	215	30.71
Abe R, 2013, J Ethnopharmacol	10.1016/j.jep.2012.11.029	175	13.46
Abas F, 2006, Food Chem	10.1016/j.foodchem.2005.01.034	172	8.60
Jain A, 2005, J Ethnopharmacol	10.1016/j.jep.2005.05.047	153	7.29

International Collaboration Network

The co-authorship network demonstrated that Indonesia and India served as primary hubs in global *Pandanus* spp. research. Indonesia maintained strong collaborative ties with Malaysia, Thailand, Japan, Australia, and the United States, while India was closely connected to Indonesia, Malaysia, and Germany. Japan and Thailand formed an additional cluster linking Asian and European research partners, indicating a predominantly Asia-centered but globally connected research landscape (Figure 3).

Figure 3. International collaboration network in *Pandanus* spp. pharmacological research, where node size indicates publication volume and link thickness represents collaboration strength.

Journal Co-Citation Network

Journal co-citation mapping identified the *Journal of Ethnopharmacology* as the most central and frequently co-cited source, exhibiting strong citation links with *Natural Product Communications*, *Tetrahedron Letters*, and *Economic Botany*. Other notable clusters included food science journals (*Food Research*), chemical and pharmaceutical journals (*Arabian Journal of Chemistry*, *Biomedical and Pharmacology Journal*), and sustainability-focused journals (*Journal of Sustainability Science*) (Figure 4).

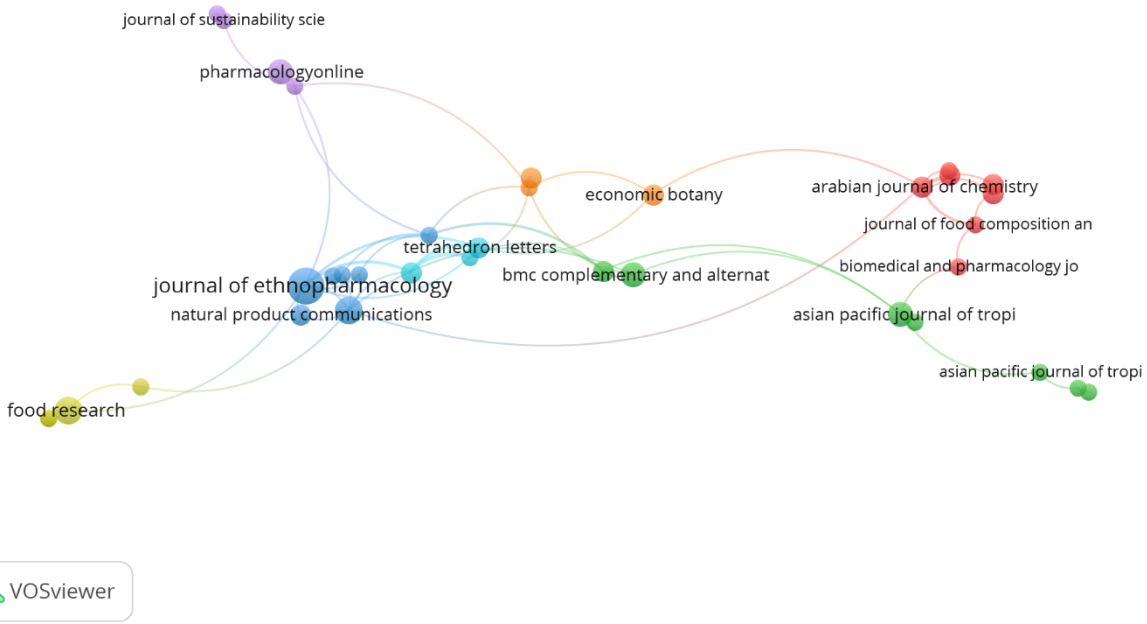

Figure 4. Journal co-citation network in *Pandanus* spp. research, illustrating key citation clusters across ethnopharmacology, phytochemistry, food science, and sustainability studies.

Keyword Co-Occurrence Analysis

Keyword mapping revealed four distinct thematic clusters. The red cluster was dominated by terms such as “plant extract,” “antioxidant,” and “flavonoid,” representing phytochemical composition and antioxidant activity research. The green cluster focused on taxonomy and bioactive compound isolation, including keywords like “Pandanus amaryllifolius,” “medicinal plant,” and “alkaloid.” The blue cluster centered on pharmacology and metabolism, including “metabolism,” “drug effect,” and “fruit,” while the yellow cluster emphasized ethnomedicinal applications with terms such as “traditional medicine,” “plant root,” and “glucose blood level” (Figure 5).

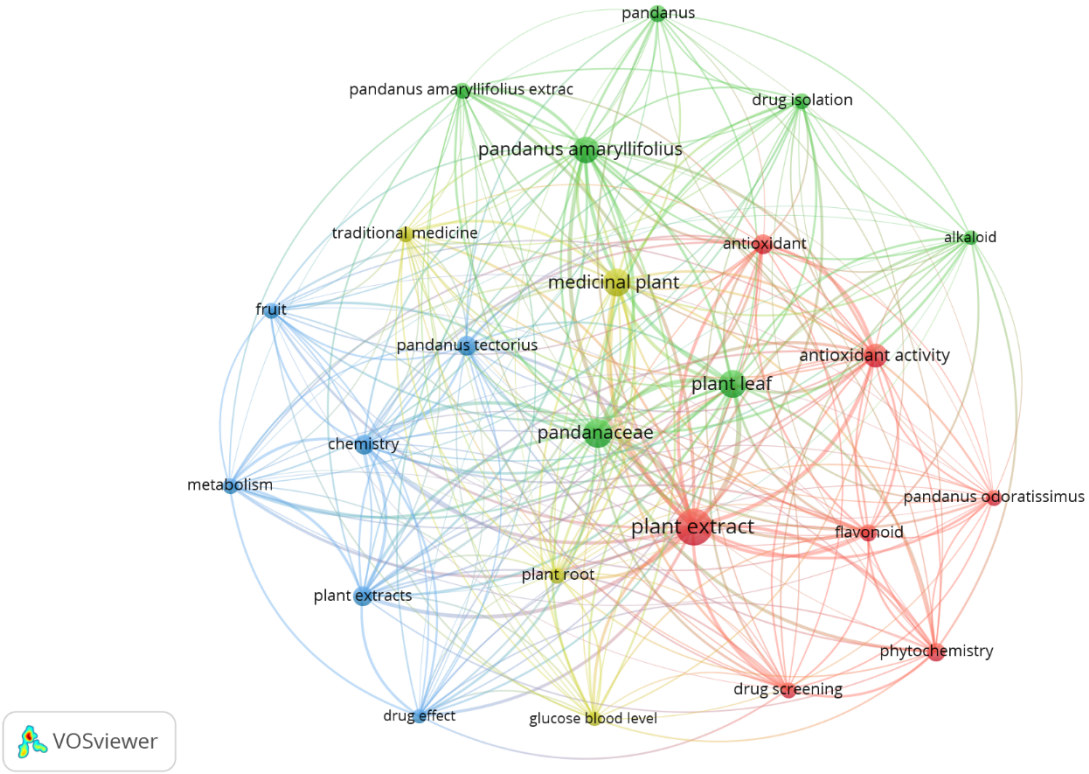

Figure 5. Keyword co-occurrence network showing four thematic clusters in *Pandanus* spp. research, generated using VOSviewer, with node size proportional to keyword frequency.

Discussion

To the best of our knowledge, this is the first study to comprehensively map the global research landscape on *Pandanus* spp. pharmacological potential and bioactivity using a bibliometric approach based on the Scopus database. The structured analysis revealed patterns in publication trends, key authors and institutions, most cited works, international collaboration, journal co-citation, and thematic keyword clusters, offering a holistic view of the field’s intellectual structure and evolution.

Publication Trends and Citation Relevance

The temporal distribution of publications from 1984 to 2004 illustrates a steady progression from sporadic early studies to more consistent scholarly activity (Newman, 2004). The earliest

publications dating back 42, 34, and 30 years continue to receive citations, highlighting the foundational value of early taxonomic descriptions, ethnomedicinal documentation, and preliminary phytochemical analyses (Harvey et al., 2015). Such sustained citation longevity is common in ethnopharmacology, where seminal works often remain relevant due to their role in preserving traditional knowledge and guiding subsequent experimental validation (Goh et al., 2020). The modest yet steady increase in publication volume between 1998 and 2004 coincides with a broader surge in natural product research globally, driven by recognition of plant-based compounds as promising therapeutic agents (Rutz et al., 2022). The persistence of moderate annual outputs in later years suggests that while *Pandanus* research is niche, it sustains enduring scientific interest anchored in regional ethnomedicinal practices (Sorkin et al., 2016).

Most Relevant Authors

The concentration of productivity among a small cohort of prolific researchers, particularly Nonato MG with 13 publications, reflects a "core–periphery" authorship structure. Such concentration enables thematic continuity, methodological refinement, and leadership in setting research agendas. The presence of Kitajima M, Takayama H, and Tan MA, each contributing nine publications, indicates international engagement from research groups in Japan and the Philippines, regions with historical expertise in natural products chemistry (sitasi, cari hasil pengobatan tradisional dari jepang dan Filipina, terkhusus pada penggunaan herbal). The breadth of secondary contributors ranging from four to eight publications suggests a moderately diverse author base, supporting both sustained leadership and periodic influx of new perspectives, which is beneficial for field expansion and innovation (Sengur, 2023).

Institutional Contributions

The dominance of Universiti Malaysia Terengganu (61 publications) and Universiti Putra Malaysia (28 publications) underscores Malaysia's position as a leading research hub for *Pandanus* spp. studies. This prominence can be attributed to the abundance of *Pandanus* species in Southeast Asia and governmental policies promoting the exploration of indigenous biodiversity for pharmaceutical and nutraceutical development (Adkar & Bhaskar, 2014a; Liu & Lu, 2014). Strong outputs from Chiang Mai University, University of Santo Tomas, and Universiti Teknologi MARA further reflect regional research investment. The inclusion of Japanese, Indonesian, and Thai universities among the top institutions highlights the geographically concentrated yet regionally interconnected nature of this research, often supported by cross-border collaborations and shared access to botanical resources (Van Den Broek et al., 2019).

Most Cited Publications

The citation analysis reveals that highly cited works, such as Patel DK (2012) with over 600 citations, often address broad pharmacological themes like antioxidant activity, antidiabetic potential, and general bioactivity profiling topics with wide applicability across biomedical research. The high annual citation rate of more recent works, such as Hussain A (2019), reflects the rising importance of integrating *Pandanus*-derived compounds into advanced chemical synthesis and pharmacological testing frameworks (sitasi). These influential publications demonstrate the dual appeal of *Pandanus* spp. research: the capacity to address global health concerns through phytochemistry and its potential contributions to sustainable bioproduct development (Wang et al., 2024).

International Collaboration Network

The co-authorship mapping indicates that Indonesia and India serve as pivotal nodes in the global *Pandanus* research network (sitasi pake Ullah et al.). Their collaborations with Malaysia, Thailand, Japan, and Australia suggest a regional alliance shaped by both shared biodiversity and cultural familiarity with *Pandanus* in traditional medicine (Adkar & Bhaskar, 2014b). Secondary partnerships with the United States and Germany provide access to advanced analytical platforms, potentially accelerating drug discovery efforts (Samby et al., 2022). These patterns mirror broader ethnopharmacological research trends, where biodiversity-rich nations form strategic alliances with technologically advanced countries to merge traditional knowledge with modern pharmacological methodologies (Samby et al., 2022).

Journal Co-Citation Network

The *Journal of Ethnopharmacology* emerges as the central knowledge hub, serving as a primary platform for disseminating interdisciplinary research that integrates ethnobotany, phytochemistry, and pharmacology. Strong co-citation linkages with *Natural Product Communications*, *Tetrahedron Letters*, and food science journals indicate an interconnected scholarly ecosystem where chemical characterization studies inform both medicinal and nutritional applications. The presence of sustainability-focused journals in the co-citation network further underscores the potential of *Pandanus* spp. research to contribute to eco-innovations, circular bioeconomy initiatives, and sustainable resource utilization (Pal et al., 2024).

Keyword Co-Occurrence Analysis

The four thematic clusters identified in the keyword mapping provide a nuanced view of the field's multidimensional nature:

- **R**ed cluster (phytochemistry and antioxidant activity)**:** Core research area focused on chemical profiling (e.g., flavonoids, alkaloids) and antioxidant assays, which are crucial for validating ethnomedicinal claims (P et al., 2024).
- Green cluster (taxonomy and bioactive compound isolation): Foundational for ensuring species-specific accuracy in pharmacological studies and facilitating reproducibility.
- Blue cluster (pharmacology and metabolism): Explores mechanisms of action, metabolite profiling, and pharmacodynamic effects—critical steps toward translational drug development (Prusty, 2024).
- Yellow cluster (ethnomedicine and disease-specific applications): Anchored in traditional use, particularly for managing metabolic disorders such as diabetes, suggesting a strong public health relevance (Chandra et al., 2023).
- The integration of these thematic domains illustrates a research continuum from botanical identification to applied pharmacology, emphasizing the need for coordinated pipelines that bridge discovery with clinical validation.

Restate the Key Findings

This study provides the first comprehensive bibliometric mapping of global research on the pharmacological potential and bioactivity of *Pandanus* spp. using Scopus-indexed literature. Results show a steady growth in publications from 1984 to 2024, with early works retaining

citation relevance for decades. Research output is concentrated among a small group of prolific authors—led by Nonato MG—and anchored in Southeast Asian institutions, particularly Universiti Malaysia Terengganu. Collaboration networks are predominantly Asia-centered but maintain global connections. Keyword mapping revealed four thematic clusters: phytochemistry and antioxidant activity, taxonomy and compound isolation, pharmacology and metabolism, and ethnomedicine. The *Journal of Ethnopharmacology* emerged as the main knowledge hub for interdisciplinary dissemination.

Interpret the Results

The findings indicate that *Pandanus* research is a niche yet steadily expanding field, strongly influenced by its ethnomedicinal significance in Southeast Asia. The persistence of early studies in citations highlights the enduring value of foundational taxonomic and phytochemical research. The concentration of expertise in a limited number of authors and institutions facilitates thematic continuity but also underscores the need for wider participation. Thematic diversity—from compound isolation to clinical-relevant pharmacology—demonstrates the genus's multifaceted potential in drug discovery and functional food development. However, gaps in mechanistic pharmacology, pharmacokinetics, and safety evaluation point to critical areas for future research..

Compare with Previous Studies

Previous bibliometric studies on medicinal plants such as *Curcuma longa* and *Centella asiatica* have revealed similar patterns of regional concentration, reliance on ethnobotanical heritage, and thematic clustering across phytochemistry and pharmacology. In line with those findings, *Pandanus* research exhibits comparable strengths in phytochemical exploration but lags in translational studies and advanced mechanistic evaluations. Unlike some better-known medicinal plants with established global research networks, *Pandanus* remains underrepresented internationally, which may be due to limited awareness beyond its native regions.

Highlight the Implications

The study's insights can guide strategic investment in *Pandanus*-related research, promoting cross-disciplinary collaboration to bridge traditional knowledge with modern pharmacology. Strengthening global partnerships, diversifying authorship, and focusing on safety, pharmacokinetics, and clinical translation will be essential to fully realize the genus's therapeutic potential. For policy and industry, the mapped knowledge structure offers a blueprint for biodiversity-driven innovation in health and wellness products.

Discuss the Limitations

This research equips local communities, policymakers, and industries particularly in Southeast Asia with evidence-based insights to maximize the sustainable use of *Pandanus* resources. By identifying key research trends and gaps, the findings can support the development of community-based cultivation, processing, and product innovation programs, fostering economic growth while preserving biodiversity. Public health initiatives can also benefit from integrating *Pandanus*-derived products into nutrition and wellness strategies, strengthening the role of indigenous plants in modern healthcare.

Suggest Future Research

Future research should broaden data coverage by incorporating multiple bibliographic databases and gray literature to provide a more complete picture of *Pandanus* research. Advanced text-mining and machine learning tools could be used to capture studies where *Pandanus* compounds are investigated but not explicitly identified in bibliographic metadata. Beyond mapping, targeted systematic reviews and meta-analyses should evaluate the quality, reproducibility, and translational potential of pharmacological studies. Experimental research should focus on mechanistic pharmacology, pharmacokinetics, safety assessments, and dose–response relationships to bridge the gap between preclinical findings and clinical application. Expanding international collaboration beyond the current Asia-centered network will help diversify perspectives, integrate high-throughput screening technologies, and explore underrepresented species within the genus. Moreover, interdisciplinary projects combining ethnobotany, phytochemistry, pharmacology, and biotechnology could drive the development of standardized *Pandanus*-based nutraceuticals, pharmaceuticals, and functional foods, fostering both scientific advancement and socio-economic benefits.

Conclusion

This bibliometric analysis provides the first comprehensive mapping of global *Pandanus* spp. research on pharmacological potential and bioactivity, revealing a niche yet steadily evolving field driven by a core group of prolific authors, leading Southeast Asian institutions, and regionally centered but globally connected collaborations. Thematic clusters spanning phytochemistry, taxonomy, pharmacology, and ethnomedicine highlight the plant's multidimensional relevance, particularly for antioxidant and metabolic health applications. The *Journal of Ethnopharmacology* and other interdisciplinary outlets serve as key knowledge hubs, facilitating integration between traditional knowledge, modern pharmacological research, and sustainability considerations. While foundational studies continue to shape the field, significant gaps remain in mechanistic pharmacology, pharmacokinetics, and translational research, underscoring the need for expanded international collaboration and advanced analytical approaches to fully harness the therapeutic potential of *Pandanus* spp.

Community Implication

The growing body of evidence on Pan*danus spp.* can benefit communities by promoting the development of affordable, plant-based therapies and functional foods that support public health, particularly in low and middle income countries where access to conventional pharmaceuticals may be limited. Sustainable utilization of mango by-products for bioactive compound extraction can also reduce agricultural waste and provide new income streams for rural farmers. These outcomes support broader goals of environmental sustainability, local economic empowerment, and improved health equity

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