Proceedings Academic Universitas Jambi
Volume 1, Issue 2, November, 2025

Global research trends on *Areca catechu L.* (Areca nut): A bibliometric analysis from 1970 to 2025

Ave Olivia Rahman[1,3,*], Didik Gunawan Tamtomo[1], Adi Prayitno[1], Dicky Moch. Rizal[2], Vitri Widyaningsih[1], Risya Cilmiaty A.R[1], Paramasari Dirgahayu[1]

[1] Doctoral Program of Medicine Sciences, Faculty of Medicine, Universitas Sebelas Maret, Surakarta, Indonesia.
[2] Department of Physiology and Andrology, Faculty of Medicine, Public Health and Nursing, Universitas Gadjah Mada, Yogyakarta, Indonesia.
[3] Department of Pharmacology, Faculty of Medicine and Health Sciences, Universitas Jambi, Jambi, Indonesia.

*Corresponding author: aveoliviarahman@unja.ac.id

Abstract

Background: *Areca catechu L.* (*A. catechu*), known as areca or betel nut palm, is a tropical tree widely cultivated across South and Southeast Asia, the Pacific Islands, and parts of East Africa. Over the past five decades, *A. catechu* has garnered substantial scientific attention. Previous bibliometric studies have primarily focused on areca nut as a risk factor in relation to oral health conditions. **Methods:** A bibliometric analysis of 2,869 publications from 1970 to 2025 was conducted using the Bibliometrix R package (biblioshiny 5.0) to evaluate research trends and collaboration networks. **Results:** The average yearly growth rate of publications was 7.24%, with India leading the way in terms of publications. The most active author, affiliation, and source are Yang SF, Kaohsiung Medical University, Journal of Oral Pathology & Medicine, respectively. The main topic in the medical field was oral lesions and the risk factors associated with betel nut chewing, including arecoline and oral fibrosis. Emerging topics included antibacterial, antioxidant, and composite material engineering, as well as adsorbents and natural fibers, which are also gaining attention in non-medical fields. **Conclusion:** Countries with the highest *A. catechu* plantation production are the most prolific in journal publications. The utilization of areca nut plantation products can be directed towards research into their potential as a natural fiber, hybrid composite, and their polyphenolic compounds as antibacterial and antioxidant agents.

Keywords: bibliometrics; global research; research trend; scientometrics; thematic map

Cite This Article

Rahman, A. O., Tamtomo, D. G., Prayitno, A., Rizal, D. M., Widyaningsih, V., A.R, R. C., & Dirgahayu, P. (2025). Global research trends on Areca catechu L. (Areca nut): A bibliometric analysis from 1970 to 2025. *Proceedings Academic Universitas Jambi*, *1*(2), 889–906.

Editor

I Made Dwi Mertha Adnyana, M.Ked.Trop.

Article info

Received: October 04, 2025. Revised: October 30, 2025. Accepted: November 09, 2025

INTRODUCTION

Areca catechu L., (*A. catechu*) commonly known as the areca or betel nut palm, is a tropical tree widely cultivated across South and Southeast Asia, the Pacific Islands, and parts of East Africa. Its seed, namely as areca nut or betel nut, is the more commonly utilized and economically valuable part of this tree. Areca nut is deeply embedded in cultural traditions, social rituals, and religious ceremonies, and is often used as a masticatory substance, typically paired with betel leaf and lime. Areca nut is also used in traditional medicine as an ingredient in a mixture (1). Other parts of this tree, including the husk, leaf sheath, stem, roots, and inflorescences, have also been utilized locally as natural fibers, construction timber, poles, fuel, biodegradable plates, tanning agents, and traditional medicine (2).

Over the past five decades, areca nut has garnered substantial scientific attention due to its pharmacological potential and association with adverse health outcomes, resulting in extensive yet heterogeneous findings. Studies have reported diverse biological effects, including antioxidant, antimicrobial, and anti-inflammatory properties. At the same time, others have emphasized its carcinogenicity and systemic toxicity, particularly linked to arecoline, the principal alkaloid component (3,4).

Previous bibliometric studies have mainly focused on areca nut as a risk factor in relation to oral health conditions, such as oral submucous fibrosis or oral precancerous/cancerous lesions (5). Given the rapid expansion of areca nut–related publications over the past few decades (5), a comprehensive bibliometric analysis is warranted to map global research trends and conceptual structures in this field. Bibliometric analysis enables the systematic quantification of scientific production, the identification of influential authors, countries, and journals, and the detection of emerging thematic areas over time. While several narrative and systematic reviews have explored the biological and clinical effects of areca nut consumption, no study to date has provided a quantitative overview of the scientific landscape underlying research on areca nut. This study conducted a 55-year bibliometric analysis of *A. catechu* (1975-2025) using the Web of Science database, which provides higher-quality bibliographic data (6). The study aims to map global publication trends, research collaborations, conceptual structure, and thematic evolution, providing an integrated overview of medical and non-medical research domains.

METHODS

This bibliometric study of *A. catechu* research used Biblioshiny 5.0 for analytical assessment and visualization. This analytical workflow consisted of three main components: quantification of publication trends and collaboration patterns, visualizations of conceptual structures to identify research clusters and emerging topics, and a review of domain-specific research reported in both medical and non-medical fields. This bibliometric study of *A. catechu* research used Biblioshiny 5.0 for analytical assessment and visualization. This analytical workflow consisted of three main components: quantification of publication trends and collaboration patterns, visualizations of conceptual structures to identify research clusters and emerging topics, and a review of domain-specific research reported in both medical and non-medical fields.

Data source and search strategy

All bibliographic data were retrieved from the Web of Science Core Collection, which was selected for its reliable citation indexing and broad coverage across scientific disciplines (6). The search was conducted using the query “Areca catechu” OR

"arecanut" OR "areca nut" OR "betel nut" OR "betelnut" OR "betel-nut" in Topic. This query searched title, abstract, keyword plus, and author keywords. The time span was set from 2025 to 1970, encompassing 55 years of research publications. The search was conducted with restrictions on the English-language articles and the proceeding paper. The retrieved records were exported in plain text format, including complete bibliographic information, abstracts, keywords, citations, and affiliations on 23 October 2025.

Data cleaning and preparation

Data were downloaded in annual batches (plain text format) and merged using Notepad++. The total number of merged documents matched the total number of documents recorded in the database. No duplication document was found. The data were also downloaded in Excel format, and documents were manually reviewed for all titles and abstracts to ensure consistency with the research cluster (7). The normalized authors' keywords were generated by creating a thesaurus file.

Bibliometric and networking analysis

Quantitative analyses were conducted using the Bibliometrix R package and its web-based interface, Biblioshiny 5.0. (8). Descriptive indicators, including annual publication trends, most productive authors, countries, institutions, and journals, were computed to assess research productivity (9,10). Networking interpretation is achieved by setting the parameter to view the top list of authors, sources, and countries relevant to publications. Global collaborations were analyzed in the countries and the author network. The number of three-field plot items, to visualize bridges between the author, keywords, and sources, was set to 30 items to broaden coverage.

Documents downloaded from the database were visualized for the author's keywords (DE), keyword plus (ID), and subject category (WoS) fields. The author's keywords before normalization were compared to keywords after normalization. The normalization was done by creating a thesaurus file. The thesaurus file was added appropriately to the analysis. Terms of words were analyzed for the most frequent words in each field, a tree map, and a trend topic of the authors' keywords. The conceptual structure comprises two approaches: the network and factorial approaches (11). The Network approach was analyzed using co-occurrence analysis, a thematic map, and the thematic evolution of the author's keywords network. The thematic mapping was applied to explore the conceptual structure and evolution of research themes within the network, enabling the identification of emerging topics and potential directions for future studies (10).

Co-occurrence analysis in the author's keywords networking

Co-occurrence analysis was performed using the author's keyword (DE) fields. Methods were set to default parameters with the thesaurus file and stop word added (automatic layout, Walktrap clustering algorithm, association normalization, no node colors by year, 50 nodes, repulsion force 0.1, no removal of isolated nodes, and a minimum number of edges of 2; the graph was also set to default parameters.

Thematic map

Thematic map analysis in Authors' keywords network set to parameters; number of words = 750, min cluster frequency (per thousand docs) = 10, number of labels = 3, Walktrap clustering algorithm, and community repulsion = 0), with the added thesaurus file and stop word list. The graph's clusters represent the research's topics,

and the clusters' sizes show how they relate to the total number of terms. The motor themes, which are defined by both high density and centrality, are represented by the quadrant in the upper-right position. In contrast, the basic themes, which are defined by high centrality but low density, are highlighted by the quadrant in the lower-right position. The themes in the bottom-left quadrant are described as developing themes with low centrality and density. In contrast, the upper-right quadrant displays the specialty themes of the field under study (12).

Thematic evolution

Thematic evolution analysis was done in the DE network with parameters setting number of words=770, min cluster frequency (per thousand docs) = 10, weight index was inclusion index weighted by word-occurrences, min weight index = 0,1, number of labels for each cluster = 3, Walktrap clustering algorithm, thesaurus file and stop word adding, time slices were done by number of cutting points = 3, where year 2000 as cutting year 1, year 2010 as cutting year 2 and 2020 as cutting year 3.

Factorial analysis

The factorial analysis was performed in the DE network using the Multiple Correspondence Analysis (MCA) method. The method parameters were set to a number of clusters = 2 and a number of terms = 50, whereas the graphical parameters were set to a label size = 10 and a number of documents = 5. The thesaurus file and stop word were added in text editing. Factorial analysis is a statistical procedure used to identify the smallest number of factors that can represent the relationship between several variables (13). Results are interpreted based on the comparative positions (nearness of words) of points and their dispersion along the dimension; closer words are more similar in distribution (14). In other words, this determines the closeness between keywords and the overall topic (13).

Brief research review

Following the bibliometric mapping, all retrieved documents were manually reviewed based on the abstract and categorized into two major domains: medical and non-medical research. First, the sources or subject areas that represent medical and non-medical themes were identified. The keywords and abstracts were reviewed and summarized in tables. These methods can identify dominant topics and emerging research directions -(15).

RESULTS

General characteristics of the dataset

A total of 3,465 documents related to *A. catechu* (betel nut) were retrieved from the Web of Science database, covering the period from 1970 to 2025. After filtering to include only original research articles and conference papers published in English, 2,869 records were retained for analysis. The document identification process is presented in Figure 1.

The annual publication trend demonstrated a consistent increase in scientific output, with an average yearly growth rate of 7.24%. Research activity was minimal before 2000, reflecting the limited scientific attention to *A. catechu* during that period. However, Publications showed a marked rise after 2020, reflecting growing scientific interest in this field (Figure 2). The documents originated from 1,283 different sources and involved 9,444 authors, with an international co-authorship rate of 19.94% and an average of 5.45 co-authors per publication. In total, 6,496 author keywords and 73,594

cited references were identified. The average document age was 10.9 years, and the average citation rate was 19.92 citations per document. These metrics suggest that the field maintains a stable and sustained scholarly impact, with influential earlier works continuing to shape recent investigations.

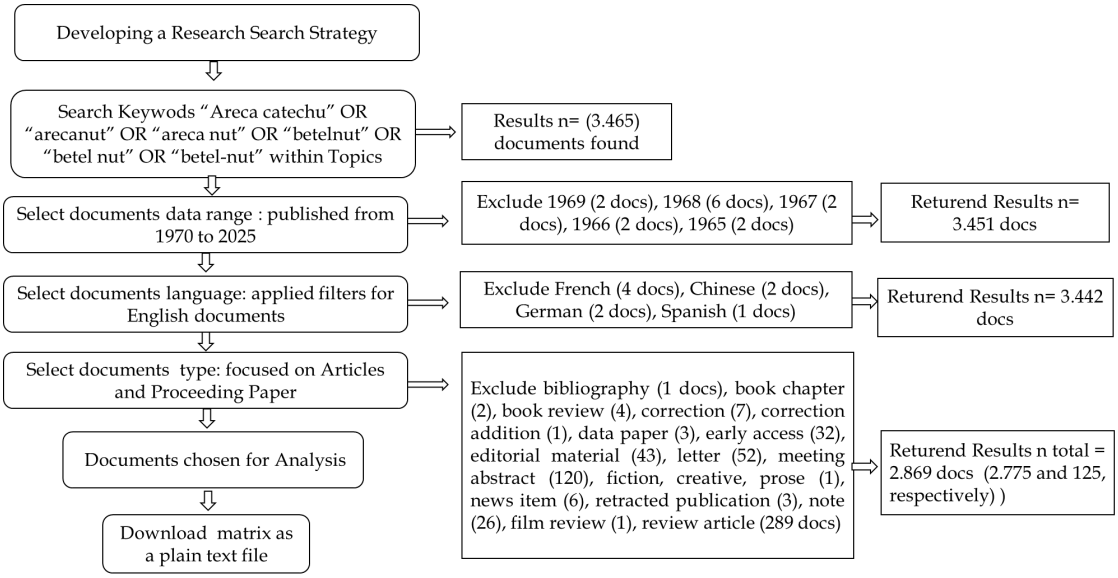

Figure 1. Article identification process. The database was downloaded on 23 October 2025

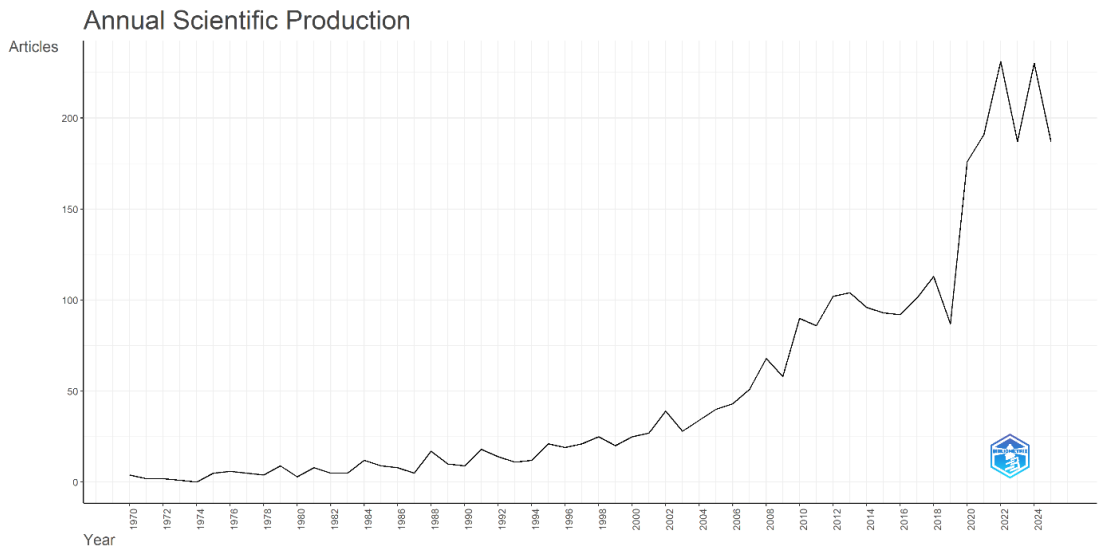

Figure 2. Annual scientific production over a period of time of total documents that meet the criteria in the identification process from Web of Science database in the *A. catechu* research.

Most productive authors, institutions, and countries

The top 3 most relevant authors with the highest number of document publications were Yang SF, Ko YC, and Chang YC. The author's production over time is presented in Figure 3.

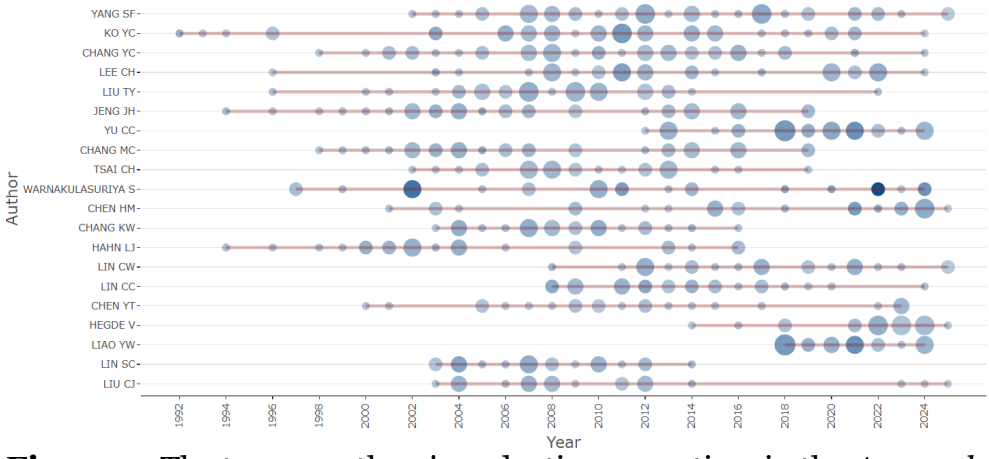

Figure 3. The top 20 authors' productions over time in the *A. catechu* research.

The most locally cited authors' field analysis, led by Warnakulasuriya S, Hahn LJ, Jeng JH, Ko YC, Gupta PC, Chang YC, Bartsch H, Liu TY, and Lee CH, identified the top 10 most-cited authors. For the authors' local impact, Warnakulasuriya S, Ko YC, Jeng JH, Chang MC, Hahn LJ, Gupta PC, Stich HF, Chang YC, Chang KW, and Lee CH were included in the top 10 list. The author collaboration network is presented in Figure 4.

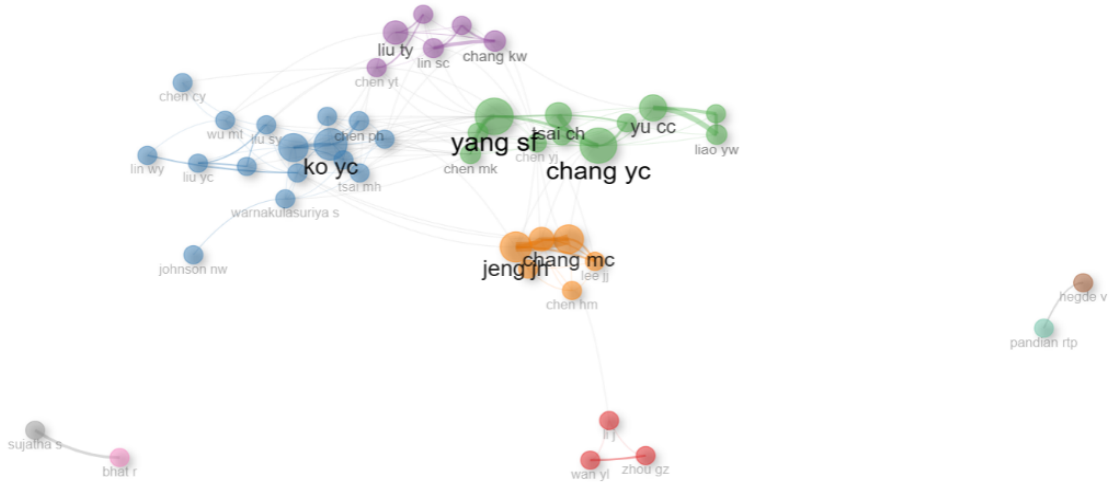

Figure 4. Author collaboration network

The most productive authors were primarily affiliated with research institutions in Taiwan and India. The top 10 leading institutions were located in Taiwan, including Kaohsiung Medical University and Chung Shan Medical University, and others. The Indian Council of Agricultural Research (ICAR) ranked fifth. The countries' scientific production field was led by India with 35.6% of total publications, followed by Taiwan (24.18%) and China (15.22%). The global collaboration network of countries is presented in Figure 5.

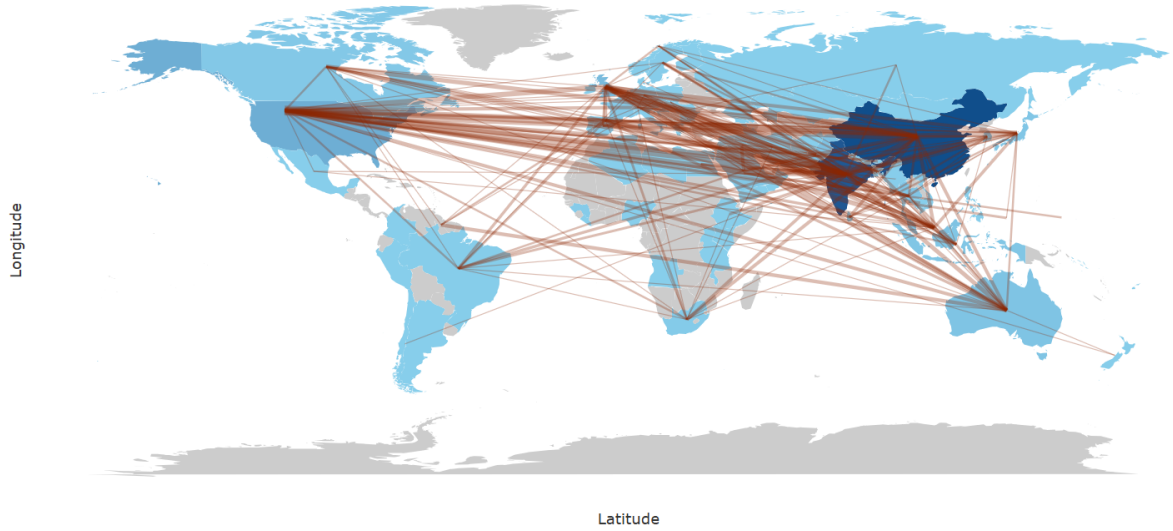

Figure 5. The global collaboration network among countries publishing research on *A. catechu*. The darker blue shades indicate countries with higher publication output, while lighter blue tones represent lower output. The connecting lines (edges) depict co-authorship links between countries; the thicker and denser the line, the stronger the collaboration. This collaboration map reveals a geographically diverse but Asia-centered research network, where scientific productivity and partnerships are intensely concentrated in China, India, and their collaborations with Western countries.

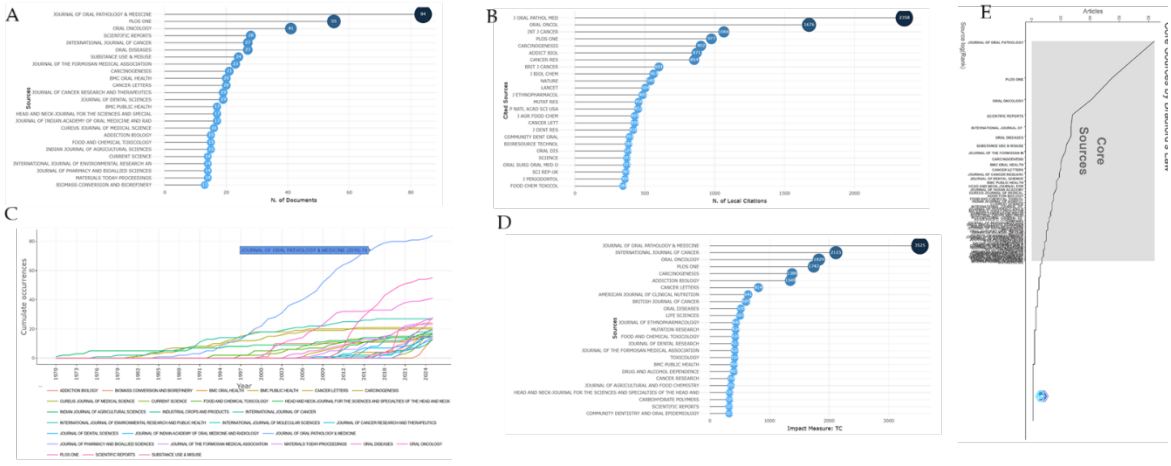

Figure 6. Top 25 most relevant sources based on predetermined searches in the database (A), top 25 most locally cited sources (B), top 25 highest sources' production over time (C), top 25 sources with the highest local impact (D), core sources by Bradford's Law (E).

An overview of the relevant sources is shown in Figure 6. Most of the document's sources were in the medical field, including dentistry, oncology, biochemistry, molecular biology, public environmental and occupational health, pharmacology, pharmacy, and toxicology. At the same time, the sources of non-medical areas include agriculture, plant science, environmental science, ecology, food science and

technology, engineering, energy and fuels, polymer science, biomass, bioenergy, biotransformation, and forestry.

Three-field Plot

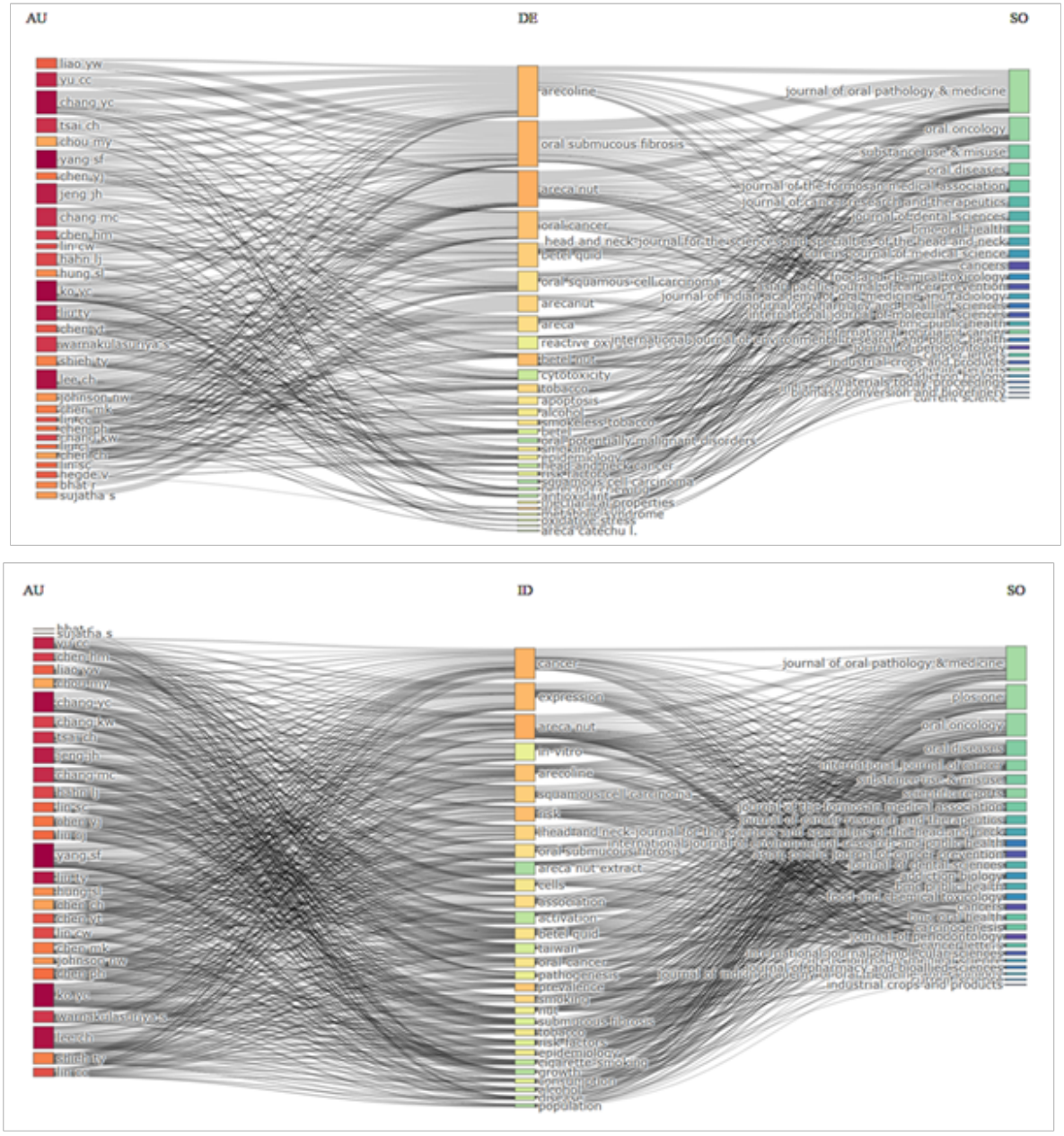

Figure 7. Comparison of the three-field plot between the author keywords and the keyword plus (n=30). Several items in the author keywords required normalization for synonyms and variations. The Keyword Plus is automatically generated by using terms that frequently appear in the titles of cited references; it's more standardized and consistent in format than author keywords.

Documents

Words networking analysis

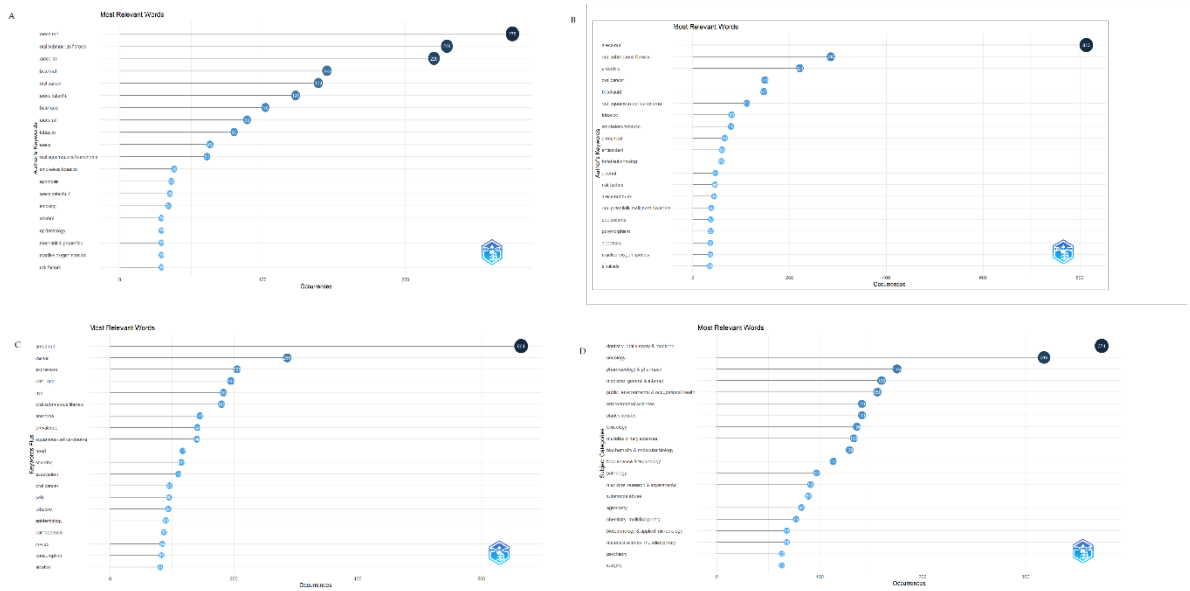

Figure 8. The most frequent word in authors' keywords field, n=20 before normalization (A), compared with after normalization with thesaurus file (B), in Keywords Plus field, n=20 (C), in subject category (WoS), n=20

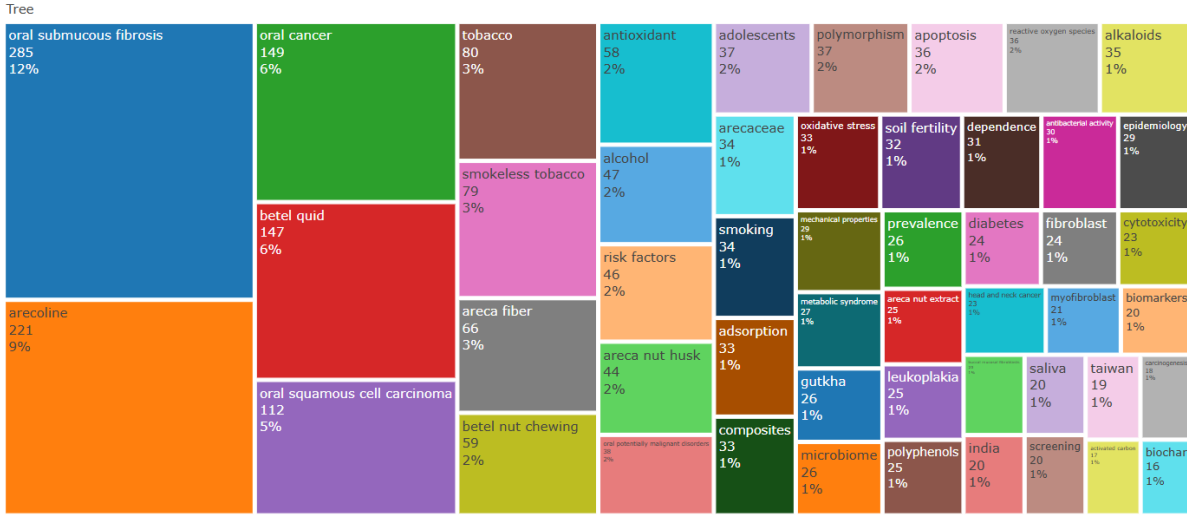

Figure 9. Tree map of authors' keywords with thesaurus file added, and remove the word "areca nut" as this is a main query searching, n=50.

Based on Figures 8 and 9, the majority of author keywords were "oral submucous fibrosis", "arecoline", "oral cancer", "betel quid", "oral squamous cell carcinoma" in the medicine area; and "areca fiber", "areca nut husk", "composite", "mechanical properties", "adsorption", and "activated carbon" in the non-medicine area.

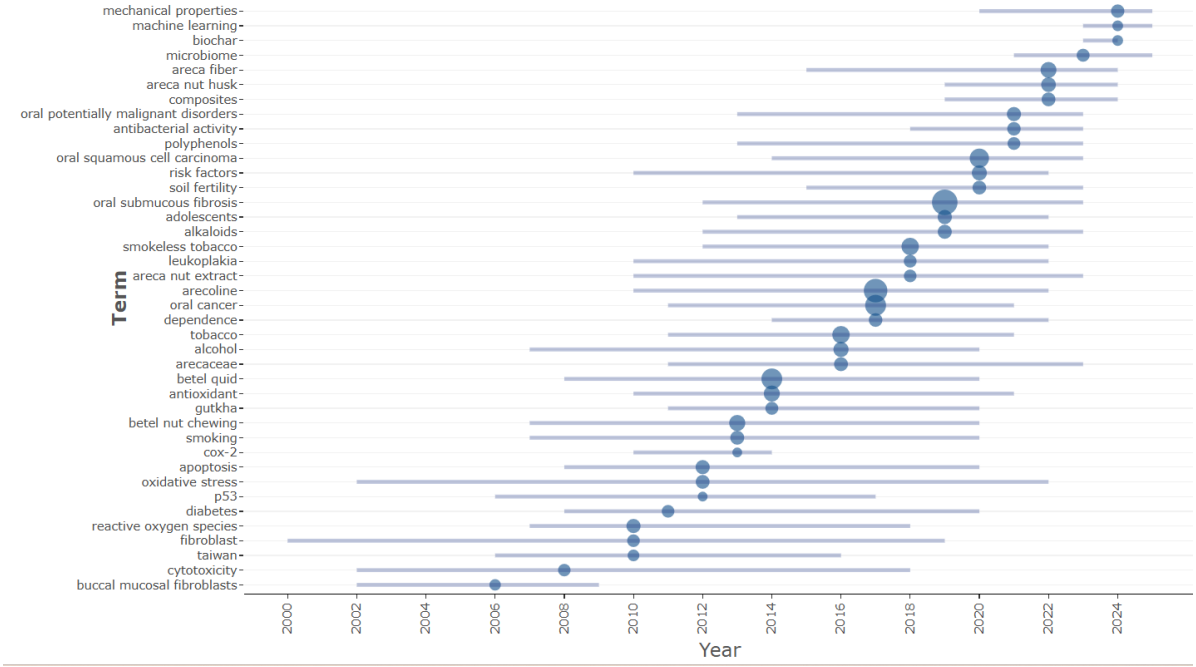

Figure 10. Trend topic with timespan 1970-2025 (23 October, 2025), set on word minimum frequency =15, n=3 word/year, with thesaurus file and remove "areca nut" word.

The most frequent word in the authors' keywords, as shown in Figure 9, was analyzed to determine the trend topic over time, as shown in Figure 10. The word "oral submucous fibrosis" was recorded with high frequency in 2019; "arecoline" was recorded with high frequency in 2017, and "betel quid" was recorded with high frequency in 2014. Whereas in the non-medical area, the word "areca fiber" was initially recorded in 2014, and the words areca nut husk", "composite", and "adsorption" were recorded in 2018, with a high frequency recorded in 2022.

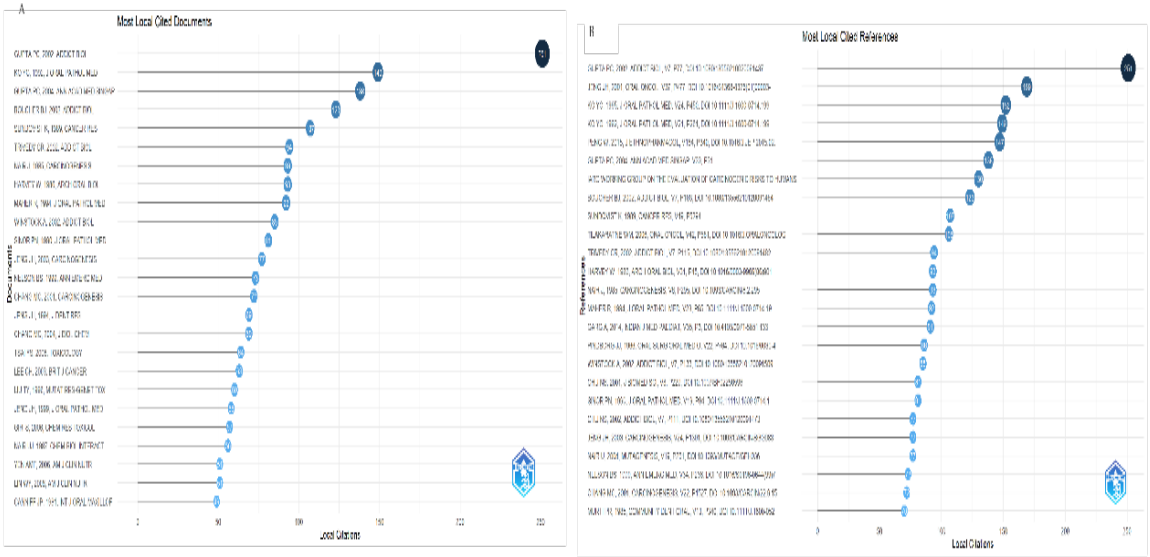

Figure 11. The top 25 most locally cited documents (A) and most locally cited references (B)

Co-occurrence network

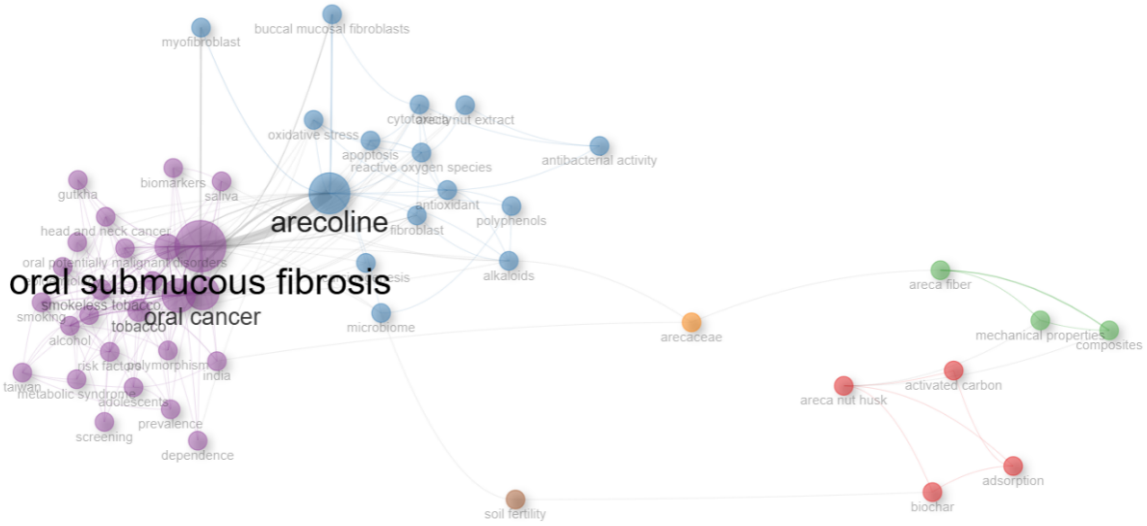

Figure 12. Co-occurrence analysis in the authors' keyword network. Analyzing with thesaurus file and stop word "areca nut". Two larger clusters (purple and blue) were identified as medical research areas, and three other clusters of lower density (green, red, orange, and brown) were identified as non-medical research areas.

Thematic map

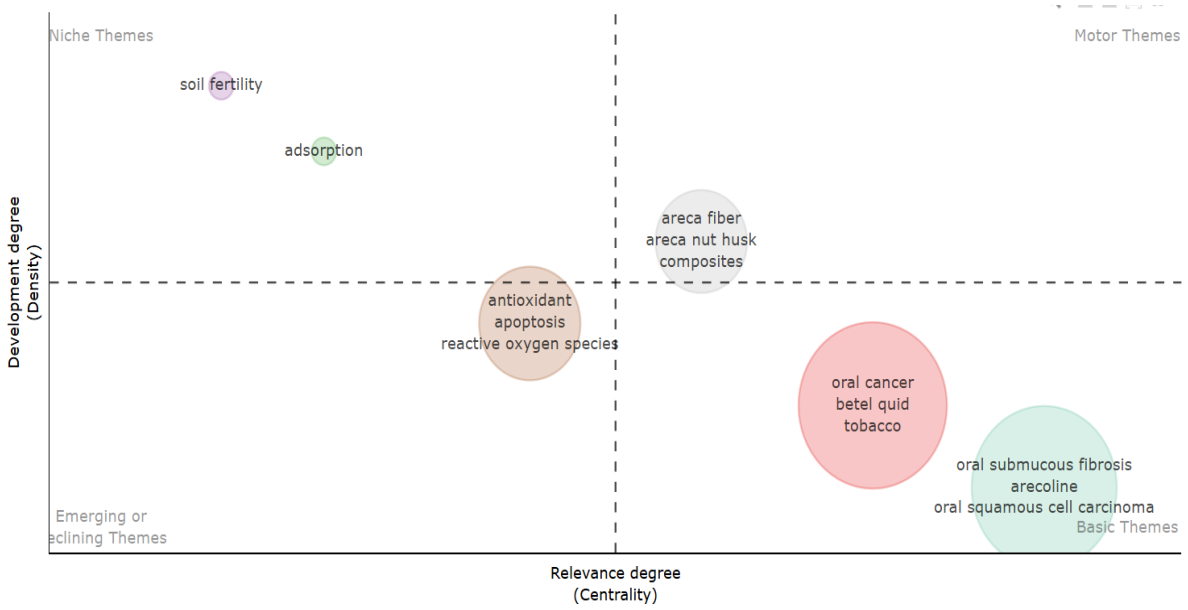

Figure 13. Thematic map analysis of the authors' keywords network. Analyzing with thesaurus file and stop word "areca nut". Based on the chosen setting parameter, there were 6 clusters: 3 clusters in the medicine subject and the others in the non-medicine subject. Two of the clusters in the medicine area focused on oral submucous fibrosis, oral cancer, and oral squamous cell carcinoma related to the use of arecoline, betel quid, and tobacco. In contrast, one cluster investigated the antioxidant properties of areca nut and the stress-oxidative-induced apoptosis mechanisms. The non-medical research clustered into areca fiber, adsorption, and soil fertility.

Thematic evolution

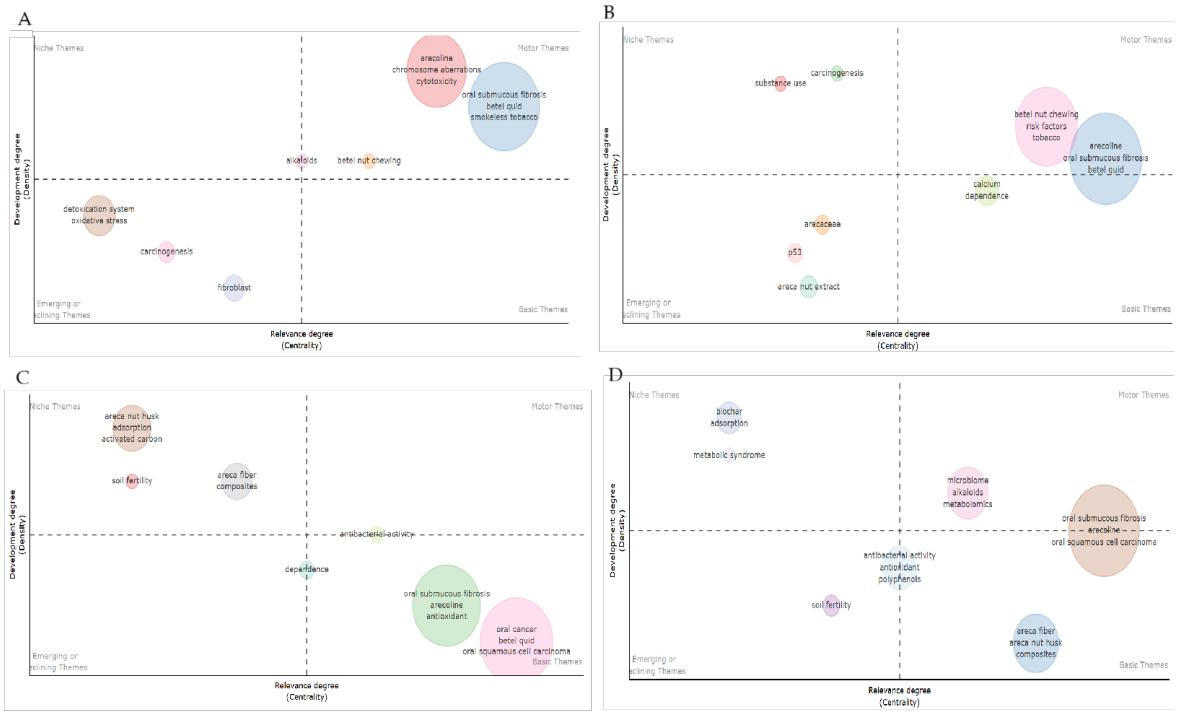

Figure 14. Thematic evolution analysis in the authors' keyword network. Period 1970-2000 (A), 2001-2010 (B); 2011-2020 (C); 2021-2025 (October) (D).

Factorial analysis

Figure 15. Factorial analysis of authors' keyword network. Cluster red represents the investigation of *A. catechu* in the medicine research, while cluster blue represents the exploration in non-medical research.

During the period 1970–2000, motor themes research was conducted in two clusters: the first studied "betel quid" and "smokeless tobacco" related to "oral submucous fibrosis", and the second cluster studied "arecoline", "chromosome aberrations", and "cytotoxicity". In the 2000-2010 period, the word "betel nut

chewing" that emerged as a small cluster in the previous period was studied more extensively, including the "risk factors" of "tobacco". The themes "dependence" and "calcium" emerged as basic themes, with low density. During the 2010-2020 period, cluster adsorbent ("areca nut husk", "adsorption" and "activated carbon"), cluster fiber ("areca fiber" and "composite"), and cluster "soil fertility" emerged in the niche theme. These clusters are categorized in non-medical research. Cluster "antibacterial activity" also emerged in this period. In the period 2020-2025, the cluster "antibacterial activity" emerged with terms "antioxidant" and "polyphenols", and the cluster "adsorption" emerged with the term "biochar". Terms "microbiome", "alkaloids", and "metabolomic" emerged as the motor theme.

Brief Research Review: Impacts of Medical vs. Non-Medical subjects

In medical research, the term oral submucous fibrosis is often used; it frequently co-occurs with oral cancer, carcinoma, and oral potentially malignant disorder. Based on a manual review of the abstracts, the sub-thematic themes include prevalence, risk factor, general population, and special populations such as maternal, lactating mothers, adolescents, geriatric, immigrant, and populations with high-risk drug abuse. The studies' methodologies include clinical observation, surveys, case-control studies, and cohort studies. Additionally, the behavior and knowledge of areca nut chewers were studied to develop a policy for cessation programs.

Molecular analyses of the pathogenesis of oral submucous fibrosis and oral carcinogenesis were conducted to investigate genetic and molecular biomarkers in humans, animal models, and buccal mucosal fibroblast cells in vitro, with the aim of exploring better-targeted therapies and facilitating early detection for diagnosis and prognosis. Arecoline-induced fibrosis was frequently used as a model. The molecular biomarkers or enzymes that were recorded in the authors' keywords include "cell cycle", various "DNA" damage, "P53", "interleukins" (recorded interleukin-8, interleukin-2, interleukin-1 alpha, interleukin-1beta, interleukin-12, interleukin-13, interleukin-19), "caspase" (recorded cas-8 and cas-3), "matrix metalloproteinase" (MMP-9,-2,-11 and -1), "lysyl oxidase"-related "collagen"; "enzymatic antioxidant" (heme oxygenase-1, superoxide dismutase, peroxidase), enzyme "17 beta-hydroxysteroid dehydrogenase", "monoamine oxidase-a", "mitogen-activated protein kinase", "acetylcholine esterase" and "adenylate cyclase".

The term "anti" refers to inhibitory action, which was recorded in the authors' keywords, including "anti-elastase", "anti-tyrosinase", "acetylcholinesterase inhibitory", "alpha-glucosidase inhibition", "anticancer", "antidepressant", "antifungal", "antidiabetic", "anti-biofilm activity", "antibiotic-resistant bacteria", "anti-fatigue", "antinematodal activity", "anticoccidial effect", "anti-aging", "anti-wrinkling", "anti-tuberculosis activity", "antinociception", "antiovulatory" and "aphrodisiac effect". Several diseases that were recorded in the author's keywords were "metabolic syndrome", "obesity", "hyperlipidemia", "hypertension", "osteoporosis", "chronic kidney disease", "stone kidney", "gastroesophageal reflux disease", "schizophrenia", and "alzheimer's disease". Based on the term "extract," several types of extracts and their effects were identified in the abstracts field (Table 1).

Table 1. The pharmacological activity of *A. catechu* is influenced by the type of extraction

Extract, Fraction or Compound	Bioactivity
Methanol extract	Scavenged superoxide anion radicals (16).

Methanol extract of *A. catechu var. dulcissima*	DPPH radical scavenging (IC_{50} < 6 μg/mL) (17).
Areca II-5-C fraction	Hypotensive effect by inhibiting angiotensin I and II in the rat model (18).
Fatty acids, procyanidins	Inhibited *S. mutans* growth and glucosyltransferase (19).
Ethanolic extract (1.7 μg arecoline/mg)	Active against bacteria, fungi, insects, and tumor cells (20).
Betel nut extracts	Active against Gram-positive and Gram-negative bacteria (21).
Methanol extract	Antinematodal activity against Bursaphelenchus xylophilus (22).
Arecoline (subtoxic dose)	Suppressed delayed-type hypersensitivity and lymphocyte activity in the rat model (23).
Aqueous ethanolic, hexane, aqueous fractions	Inhibited monoamine oxidase (MAO) activity in rat brain homogenates, demonstrated anti-depressant properties (24).
Dichloromethane fraction	Inhibited MAO-A and has antidepressant effects in the rat model (25).
Aqueous extract	Increased hippocampal serotonin and noradrenaline in rats at doses of 20–50 mg/kg (26).
Aqueous extract	Improved cognition in PTZ-induced epilepsy in the zebra fish model (27).
Arecae semen extract	Relaxed rat aortic rings (endothelium-dependent) of the rat (28).
Arecoline	antinociception (0.3-1 mg kg(-1) i.p.) in a dose-dependent manner in the rat model (29).
Aqueous fraction	Anti-inflammatory and analgesia effects exhibited at different doses (30).
Water-soluble extract (0.5%) supplementation	lowered the plasma cholesterol concentration, small intestinal pCEase activity, the absorbed cholesterol, and inhibition of intestinal ACAT that may facilitate the metabolic efficiency in rats (31).
Crude extract	spasmogenic effect in the isolated rabbit jejunum (32).
Sulfated polyphenol NF-86II-S-13.3	Inhibited HIV infection in MT-4 cells (33).
Polyphenols (NPF-86IA–IIB)	Inhibited 5′-nucleotidase from snake venom in the rat liver membrane (34), and murine macrophages (35). anti-tumor activity (36).

In the non-medical research, the theme can be categorized into two clusters: utilization of areca husk and agriculture. Terms that were recorded in the authors' keyword in the first cluster include "biomass", "waste", "husk", "adsorption", "composite", "materials", and "biochar". The term "adsorption" was followed by terms such as arsenic, Congo red, iodine, and methylene blue, where the capacity of adsorption was studied in various types of water pollutants. The term "composite" has been studied in the processing and formulation of hybridizing areca husk with other

materials, followed by an evaluation of material performance, including strength and flexibility.

The term “fiber” refers to the utilization of areca nut fiber as a natural fiber, primarily derived from the leaf sheath, which has been developed into a biodegradable fiber material. In the agriculture cluster, the terms “soil” and “yellow leaf” were primarily recorded. This area studied the identification of soil and yellow leaf to improve the quality of the areca plantation and crop production. This cluster also recorded several studies about assessing the quality of areca nut and developing feasible assessment methods. The term “agroforestry” was also recorded, followed by the terms “intercropping”, “mixed farming system”, “carbon storage”, “biodiversity”, “conservation”, and “climate change”. The term “anthropology” was also recorded in lesser quantity; this area of study focuses on the cultural behavior of chewing areca and tobacco among the migrant population.

DISCUSSION

A total of 2,869 documents were analyzed, representing a large dataset that required parameter adjustment to ensure data coherence and interpretability. The analysis used author keywords as the network basis, with a thesaurus file created to normalize terms. The keyword “areca nut” was set as a stop word since it served as the main query term in the database and could bias the visualization if retained.

Terms such as “India, Taiwan, Sri Lanka, Bangladesh, Thailand, Malaysia, Indonesia, or Papua New Guinea” were recorded in the title, abstracts, or authors’ keywords. Also, the terms “Chinese, Iranian, and Palampur” were followed by the term “traditional medicine”. This suggests that studies of areca-nut-induced oral disorders were influenced by individuals’ genetics, culture, and behavior. This could be an interesting direction for further research, such as a systematic review comparing the influence of these factors on the pathogenesis of areca nut oral disorders by region characteristics. Ethnomedicine studies are also suggested to be expanded and explored to contribute to the literature on areca catechu formulation and its use in traditional medicinal heritage.

The research also reflects interest in the phytochemical diversity of the *A. catechu*. Numerous bioactive compounds from areca catechu have been reported, using various extraction methods (Table 1). The alkaloids and polyphenols are the most studied. These compounds have been investigated through molecular docking, network pharmacology, in vitro assays, animal models, or clinical trials. However, based on the abstract reviews, it was noted that there was no continuity across the research stages of an extract action. Ideally, investigations of plant extracts should progress sequentially from in silico (molecular docking, pharmacology network) studies, which are relatively inexpensive, to in vitro, in vivo, and clinical trials (37,38).

In the non-medical subject, studies of *A. catechu* focused on the development of natural fibers from areca nut husk, leaf sheath, or stem, which are primarily agricultural waste. Additionally, the utilization of areca nut as a hybrid composite for adsorbent materials. This research can be further explored by examining these materials in the industrial sector, including their physicochemical properties, feasibility, and economic processing, as well as studies on soil quality and plant disease, to maximize crop production.

This bibliometric study relies solely on data retrieved from the Web of Science Core Collection, which may exclude relevant publications indexed in other databases such as Scopus or PubMed. Consequently, regional journals, non-English articles, and gray literature may be underrepresented, potentially biasing the assessment of global

research trends (39). The long temporal span (1970–2025) introduces variability in keywords, which may affect comparability across decades (8). Thesaurus files were used to minimize this variability by normalization into a term (synonym list). However, using an inappropriate thesaurus file can also influence the factual trend research (7). The non-medicinal research has emerged as a recent theme, especially after 2020, possibly driven by a research finding on the utilization of products from the areca nut tree other than the areca nut itself. This is likely due to the numerous reports of adverse effects associated with areca nut.

CONCLUSIONS

This bibliometric analysis provides a comprehensive overview of *A. catechu* research from 1970 to 2025, revealing a high intensity of publications. The evolution of scientific interest and thematic focus has shifted from *A. catechu*-induced oral disorders to recent studies on the utilization of agricultural waste from *A. catechu* cultivation in biocomposites and natural fibers. Recommendations for research directions include pharmacogenomic studies on the relationship between chewing betel nut and the incidence of oral cancer, through collaboration between countries with high rates of both variabels. Further research in the medical field could focus on the antioxidant and antibacterial properties of areca catechu polyphenols. In the non-medicinal field, explore the use of all parts of the tree for natural fiber, hybrid composites, and biochar.

CONFLICT OF INTEREST

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

FUNDING

This study did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

ACKNOWLEDGMENT

This study was supported and funded by the Indonesian Education Scholarship Program (Beasiswa Pendidikan Indonesia/BPI), Center for Higher Education Funding and Assessment (Pusat Pembiayaan dan Asesmen Pendidikan Tinggi/PPAPT), Ministry of Higher Education, Science, and Technology of the Republic of Indonesia, and Indonesia Endowment Fund for Education Agency (Lembaga Pengelola Dana Pendidikan/LPDP), awarded to Ave Olivia Rahman.

DECLARATION OF ARTIFICIAL INTELLIGENCE USE

This study used artificial intelligence (AI) tools and methodologies in the following capacities: visualization. AI tools, Biblioshiny 5.0, were used to generate graphs, charts, and visual summaries. Also, we confirm that all AI-assisted processes were critically reviewed by the authors to ensure the integrity and reliability of the results. The final decisions and interpretations presented in this article were solely made by the authors.

REFERENCES

[1] Singh A, Dikshit R, Chaturvedi P. Betel Nut Use: The South Asian Story. Subst Use Misuse. 2020;55(9):1545–51.
[2] Jannah M, Machfud, Sugiarto. Potential added value of areca nut products in Aceh. J Teknol Ind Pertan. 2021;31(2):190–7.
[3] Peng W, Liu YJ, Wu N, Sun T, He XY, Gao YX, et al. Areca catechu L. (Arecaceae): A review of its traditional uses, botany, phytochemistry, pharmacology and toxicology. J Ethnopharmacol. 2015;164:340–56.

[4] Sun H, Yu W, Li H, Hu X, Wang X. Bioactive Components of Areca Nut: An Overview of Their Positive Impacts Targeting Different Organs. Nutrients. 2024;16(5):695–718.
[5] Vashney M, Parmar A, Mishra AK. The past, present and future of literature pertaining to betel (areca) nut: a citation analysis. Subst Use Misuse [Internet]. 2020;55(9):1403–12. Available from: https://doi.org/10.1080/10826084.2019.1660677
[6] Sotoudeh-Anvari A. A state-of-the-art review on D number (2012-2022): A scientometric analysis. Eng Appl Artif Intell [Internet]. 2024;127(PA):107309. Available from: https://doi.org/10.1016/j.engappai.2023.107309
[7] Nowakowska M. A comprehensive approach to preprocessing data for bibliometric analysis [Internet]. Vol. 130, Scientometrics. Springer International Publishing; 2025. 5191–5225 p. Available from: https://doi.org/10.1007/s11192-025-05415-x
[8] Lim WM, Kumar S, Donthu N. How to combine and clean bibliometric data and use bibliometric tools synergistically: Guidelines using metaverse research. J Bus Res. 2024;182(May):114760. Available from: https://doi.org/10.1016/j.jbusres.2024.114760
[9] Wang G, Yu Z, Ji T, Shi L, Liu W. A scientometric study of betel quid chewing and oral cancer and precancerous lesions with distinct regional characteristic. J Dent Sci. 2023;18(3):1378–83. Available from: https://doi.org/10.1016/j.jds.2023.03.007
[10] Oyewola DO, Dada EG. Exploring machine learning: a scientometrics approach using bibliometrix and VOSviewer. SN Appl Sci [Internet]. 2022;4(5). Available from: https://doi.org/10.1007/s42452-022-05027-7
[11] Maulidiya D, Nugroho B, Santoso HB, Hasibuan ZA. Thematic evolution of smart learning environments, insights and directions from a 20-year research milestones: A bibliometric analysis. Heliyon [Internet]. 2024;10(5):e26191. Available from: https://doi.org/10.1016/j.heliyon.2024.e26191
[12] Ragazou K, Passas I, Garefalakis A, Dimou I. Investigating the Research Trends on Strategic Ambidexterity, Agility, and Open Innovation in SMEs: Perceptions from Bibliometric Analysis. J Open Innov Technol Mark Complex. 2022;8(118):1–18.
[13] Iman B, Yuadi I, Sukoco BM. Mapping Research Trends With Factorial Analysis in Organizational Politics. 2023;(December):1–16.
[14] Jordaan H. Exploring Biblioshiny for Historical Assessment of Global Research on Sustainable Use of Water in Agriculture. Sustainability. 2022;14(10651):1–34.
[15] Guo S, Cui L, Xu J, Liu M, Wang W, Xia A, et al. A global synthesis of plant-plant interaction investigations: current knowledge and future directions. Plant Soil. 2025;
[16] Ohsugi M, Fan WZ, Hase K, Xiong Q, Tezuka Y, Komatsu K, et al. Active-oxygen scavenging activity of traditional nourishing-tonic herbal medicines and active constituents of Rhodiola sacra. J Ethnopharmacol. 1999;67(1):111–9.
[17] Lee SE, Hwang HJ, Ha JS, Jeong HS, Kim JH. Screening of medicinal plant extracts for antioxidant activity. LIFE Sci. 2003;73(2):167–79.
[18] Inokuchi J ichi, Okabe H, Yamauchi T, Nagamatsu A, Nonaka G ichiro, Nishioka I. Antihypertensive substance in seeds of Areca catechu L. Vol. 38, Life Sciences. 1986. p. 1375–82.
[19] Hada S, Kakiuchi N, Hattori M, Namba T. Dental-caries prevention by traditional medicines .11. Identification of antibacterial principles against streptococcus-mutans and inhibitory principles against glucosyltransferase from the seed of areca-catechu l. Phyther Res. 1989;3(4):140-144 WE-Science Citation Index Expanded (SCI.
[20] Abbas G, Kashif M, Mudassar, Khan TA, Bhatti HA, Haque S, et al. Cytotoxic, embryotoxic, insecticidal and anti-microbial activities of standardized Areca catechu nut. Pak J Pharm Sci. 2018;31(2):385-392 WE-Science Citation Index Expanded (SCI.
[21] Panutat P, Vatanyoopaisarn S. Antibacterial activity of Thai herb and spice extracts against the potent foodborne bacteria. Franz C, Mathe A, editors. WOCMAP III: Targeted Screening of MAPs, Economics and Law. King Mongkuts Inst Technol, Fac Sci Appl, Dept Agroind Technol, Bangkok, Thailand; 2005. p. 191–6.
[22] Alen Y, Nakajima S, Nitoda T, Baba N, Kanzaki H, Kawazu K. Antinematodal activity of some tropical rainforest plants against the pinewood nematode, Bursaphelenchus

xylophilus. Zeitschrift Fur Naturforsch C-A J Biosci. 2000;55(3–4):295-299 WE-Science Citation Index Expanded (SCI.
[23] Selvan RS, Selvakumaran M, Rao AR. Influence of arecoline on immune-system .2. Suppression of thymus-dependent immune-responses and parameter of nonspecific resistance after short-term exposure. Immunopharmacol Immunotoxicol. 1991;13(3):281–309.
[24] Dar A, Khatoon S, Rahman G, AttaUrRahman. Anti-depressant activities of Areca catechu fruit extract. Phytomedicine. 1997;4(1):41–5.
[25] Dar A, Khatoon S. Behavioral and biochemical studies of dichloromethane fraction from the Areca catechu nut. Pharmacol Biochem Behav. 2000;65(1):1–6.
[26] Abbas G, Naqvi S, Erum S, Ahmed S, Atta-ur-Rahman, Dar A. Potential Antidepressant Activity of Areca catechu Nut via Elevation of Serotonin and Noradrenaline in the Hippocampus of Rats. Phyther Res. 2013;27(1):39–45.
[27] Nadig APR, Suman, Sahyadri M, Mehdi S, Krishna KL. Aqueous extract of Piper betle L. leaf and Areca catechu L. nut protects against pentylenetetrazole-induced seizures and positively modulates cognitive function in adult Zebrafish. Adv Tradit Med. 2023;23(4):1137–52.
[28] Goto H, Tanaka N, Tanigawa K, Shimada Y, Itoh T, Terasawa K. Endothelium-dependent vasodilator effect of extract prepared from the seeds of Areca catechu on isolated rat aorta. Phyther Res. 1997;11(6):457–9.
[29] Ghelardini C, Galeotti N, Lelli C, Bartolini A. M1 receptor activation is a requirement for arecoline analgesia. FARMACO. 2001;56(Workshop of the Italian-Society-of-Pharmacognosy (SIPHAR)):383–5.
[30] Khan S, Mehmood MH, Ali ANA, Ahmed FS, Dar A, Gilani AH. Studies on anti-inflammatory and analgesic activities of betel nut in rodents. J Ethnopharmacol. 2011;135(3):654–61.
[31] Park YB, Jeon SM, Byun SJ, Kim HS, Choi MS. Absorption of intestinal free cholesterol is lowered by supplementation of Areca catechu L. extract in rats. LIFE Sci. 2002;70(16):1849–59.
[32] Gilani AH, Ghayur MN, Saify ZS, Ahmed SP, Choudhary MI, Khalid A. Presence of cholinomimetic and acetylcholinesterase inhibitory constituents in betel nut. LIFE Sci. 2004;75(20):2377–89.
[33] Toukairin T, Uchino K, Mizuno T, Nakashima H, Yamamoto N, Ogawara H. New substances against human-immunodeficiency-virus - sulfated 5'-nucleotidase inhibitory polyphenols. Chem Pharm Bull (Tokyo). 1992;40(3):802-804 WE-Science Citation Index Expanded (SCI.
[34] Uchino K, Matsuo T, Iwamoto M, Tonosaki Y, Fukuchi A. New 5'-nucleotidase inhibitors, npf-86ia, npf-86ib, npf-86iia, and npf-86iib from areca-catechu .1. Isolation and biological properties. Planta Med. 1988;(5):419–22.
[35] Matsuo T, Uchino K, Toukairin T, Iwamoto M, Tonosaki Y, Akiyama T, et al. Phosphatase-inhibitory activity and activation of murine macrophages by new 5'-nucleotidase inhibitors, npf-86ia, npf-86ib, npf-86iia and npf-86iib. Chem Pharm Bull (Tokyo). 1989;37(7):1849-1851 WE-Science Citation Index Expanded (S.
[36] Iwamoto M, Matsuo T, Uchino K, Tonosaki Y, Fukuchi A. New 5'-nucleotidase inhibitors, npf-86ia, npf-86ib, npf-86iia, and npf-86iib from areca-catechu .2. Anti-tumor effects. Planta Med. 1988;(5):422-425 WE-Science Citation Index Expanded (SCI.
[37] Chaachouay N, Zidane L. Plant-Derived Natural Products: A Source for Drug Discovery and Development. Drugs Drug Candidates. 2024;3(1):184–207.
[38] Binafsha Manzoor Syed. Plant extracts for drug development: Is it economical? Liaquat Med Res J. 2025;7(1):1–2.
[39] Wang S, Isa NM, Li L, Shi K. Bibliometric visualization analysis of "World Heritage" topic in web of science database using citespace. Multidiscip Rev. 2024;7(11).