

A Bibliometric Analysis of Recent Research on Major Rice Components

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Abstract

Rice is a globally important staple crop with growing scientific attention to its value-added components. This study aimed to conduct a bibliometric analysis to map research trends related to three major rice components: rice starch, rice protein, and rice bran oil. Bibliometric data were retrieved from the Scopus database, covering publications from 2020 to early 2025. A total of 298 documents on rice starch, 141 on rice protein, and 213 on rice bran oil were analyzed using Scopus analytical tools and VOSviewer software for keyword co-occurrence and author co-citation mapping. The findings revealed a consistent growth in research output across all three components, with rice starch receiving the greatest scientific attention, followed by rice bran oil and rice protein. China demonstrated dominant research productivity across authorship, institutional contributions, and funding support. Thematic analysis indicates a strong emphasis on structural characterization, functional properties, processing technologies, and functional food applications. Cluster analysis identified four, five, and five thematic clusters for rice starch, rice protein, and rice bran oil, respectively, highlighting diverse research trajectories. Despite the increasing research output, rice protein remains comparatively underexplored. This study contributes to knowledge mapping in food science by providing a component-level bibliometric perspective and offers insights for research planning, policy development, and industrial innovation in rice-based product development. This bibliometric analysis emphasizes the dynamic and developing nature of rice research, concentrating on three primary components: rice starch, rice protein, and rice bran oil. A substantial rise in research output is evident from the upward trend of research documents between 2020 and 2025. Rice starch is the most extensively researched component, succeeded by rice bran oil and rice protein. China far surpasses other nations in global contributions regarding rice research.

Keywords: bibliometric analysis, knowledge mapping, rice bran oil, rice protein, rice starch

Introduction

Rice is one of the most important staple crops worldwide, serving as a primary food source for more than half of the global population and contributing substantially to food security, economic development, and social stability. Rice accounts for approximately 20% of global dietary energy supply, while wheat and maize contribute 19% and 5%, respectively. In many Asian countries, rice provides more than 70% of caloric intake (Muthayya et al., 2014). Moreover, rice remains the principal staple food for economically vulnerable populations in Asia and Africa who face limited access to diversified and nutritious diets (Bin Rahman & Zhang, 2023). Consequently, rice is widely recognized as a strategic commodity closely associated with poverty alleviation, employment generation, and regional stability (Fukagawa & Ziska, 2019; Zeigler & Barclay, 2008).

Structurally, the rice grain consists of endosperm (70%), husk (20%), bran (9%), and germ (1%) (Fraterrigo Garofalo et al., 2021). Postharvest milling transforms paddy into edible kernels and generates multiple value-added fractions with distinct functional properties. The endosperm contains starch and proteins that are widely used in food processing and ingredient formulation, while the lipid-rich bran fraction serves as the primary source of rice bran oil. Rice proteins, extracted from

both endosperm and bran, exhibit hypoallergenic and nutritionally favorable characteristics, supporting applications in gluten-free products and infant nutrition (Al-Doury et al., 2018). Additionally, rice husk represents an important agricultural by-product utilized in energy generation, fiberboard production, and soil improvement (Shukla et al., 2022). These diverse applications underscore the increasing industrial and nutritional relevance of rice components in supporting value-added product development and circular resource utilization.

In recent years, rice production and research have faced growing challenges, including stagnating yields in major rice-producing countries alongside increasing demand from expanding populations (Bin Rahman & Zhang, 2023). Consequently, research efforts have broadened beyond yield improvement to address global challenges such as climate resilience, sustainable processing, and functional food innovation. Emerging research areas include climate-resilient rice varieties (Singh et al., 2024), improved postharvest technologies and sustainable primary processing (Samaddar et al., 2017), as well as functional and nutraceutical rice-derived products enriched with bioactive compounds (Sundaram et al., 2023). Furthermore, advancements in food technology have enabled the development of rice-based dairy substitutes, plant-based meat analogues, fermented

beverages, and three-dimensional printed rice products with customizable textures and structures (Srikaeo, 2022; Park et al., 2025). These developments highlight the expanding scientific and industrial importance of rice-derived ingredients, particularly rice starch, rice protein, and rice bran oil.

Despite the expanding body of literature on rice and its derivatives, the scientific landscape of rice component research remains fragmented and insufficiently synthesized. Existing bibliometric studies have primarily examined rice research at an aggregate level, focusing on crop production, food security, and agricultural sustainability, with limited attention given to component-level knowledge structures. As a result, the evolution, thematic distribution, and research dynamics associated with individual rice components remain inadequately understood. This gap restricts the ability to identify emerging research themes, interdisciplinary linkages, and knowledge gaps that are essential for guiding research planning and industrial innovation.

Bibliometric analysis has emerged as a robust methodological approach within information science for mapping scholarly communication, identifying influential research actors, and visualizing knowledge structures across scientific domains. By integrating publication data with citation and keyword network analyses, bibliometric methods enable systematic examination of research productivity, collaboration patterns, and thematic evolution. Applying bibliometric techniques to rice component research provides an opportunity to bridge food science and information science perspectives, thereby offering a structured understanding of how research on rice starch, rice protein, and rice bran oil has evolved in response to global scientific priorities and technological advancements.

Given the increasing industrial relevance of rice-derived ingredients and the lack of focused component-level bibliometric mapping, a comprehensive analysis is warranted. Therefore, this study aims to conduct a bibliometric analysis of recent research on major rice components—rice starch, rice protein, and rice bran oil—using Scopus data from 2020 to early 2025. By examining publication trends, patterns of scholarly communication, and knowledge structures through keyword co-occurrence and citation network analyses, this study contributes to information science by advancing knowledge mapping of food-related research domains. Additionally, the findings are expected to support future research planning, facilitate interdisciplinary collaboration, and inform industrial innovation and knowledge management strategies related to rice-based product development.

Objectives

1. To examine the research landscape and publication trends of studies on major rice components rice

starch, rice protein, and rice bran oil using bibliometric methods to reflect the evolution of scholarly output from 2020 to early 2025.

2. To analyze patterns of scholarly communication and research productivity in rice component research, including contributions from countries, authors, institutions, funding agencies, journals, and citation structures.

3. To map the knowledge structure and thematic development of research on rice starch, rice protein, and rice bran oil through keyword co-occurrence and citation network analyses.

4. To identify research emphases and knowledge gaps that may inform future research directions and support decision-making in research planning and knowledge management related to rice-based studies.

Literature Review

Bibliometric analysis has become an established methodological approach in information science for examining the development, structure, and dynamics of scholarly knowledge across research domains. By analyzing publication and citation data, bibliometric methods enable identification of research trends, influential contributors, collaboration patterns, and thematic evolution, thereby supporting evidence-based research planning and knowledge management (Donthu et al., 2021; Zupic & Čater, 2015). With the exponential growth of scientific literature, bibliometric techniques have increasingly been used to map research landscapes and uncover intellectual structures in diverse disciplines.

In agricultural and food science research, bibliometric studies have explored global patterns of crop research, functional food development, and sustainable agriculture, demonstrating their value in understanding scientific priorities and knowledge dissemination (Ellegaard & Wallin, 2015). However, existing bibliometric studies on rice have predominantly examined rice research as a unified domain, focusing on themes such as crop productivity, food security, and sustainability. While these studies provide macro-level insights, they offer limited understanding of the knowledge structure associated with individual rice components that are central to industrial innovation and nutritional applications.

Rice-derived ingredients—including rice starch, rice protein, and rice bran oil—have gained increasing scientific attention due to their functional and nutritional properties. Rice starch is widely studied for its physicochemical characteristics and applications in food processing and biodegradable materials, whereas rice bran oil has been investigated for its bioactive compounds and health-promoting properties. Rice protein has emerged as a promising plant-based protein source with hypoallergenic characteristics and functional potential (Al-Doury et al., 2018; Sundaram et al., 2023). Despite their importance,

the research distribution, thematic focus, and intellectual structure of studies on these rice components remain insufficiently synthesized.

Keyword co-occurrence and citation network analyses are widely employed in bibliometric research to reveal thematic clusters and intellectual structures within scientific fields (Van Eck & Waltman, 2014). These techniques facilitate identification of dominant research themes and emerging knowledge gaps. Applying such methods to rice component research can provide insights into research evolution, interdisciplinary linkages, and regional knowledge distribution.

Therefore, a focused bibliometric investigation of major rice components is necessary to bridge this knowledge gap. Such analysis contributes to information science by advancing knowledge mapping of food-related research domains and supports strategic research planning and industrial decision-making related to rice-based product innovation. Drawing upon prior bibliometric literature and the identified research gap, this study adopts an analytical framework that conceptualizes rice component research through three interconnected dimensions: research productivity, scholarly communication patterns, and knowledge structure, thereby providing a systematic foundation for bibliometric knowledge mapping and trend interpretation. This framework informed the selection of bibliometric indicators and analytical tools employed in the methodology, ensuring conceptual coherence and methodological transparency throughout the research process.

■ Methodology

Design and Database Selection

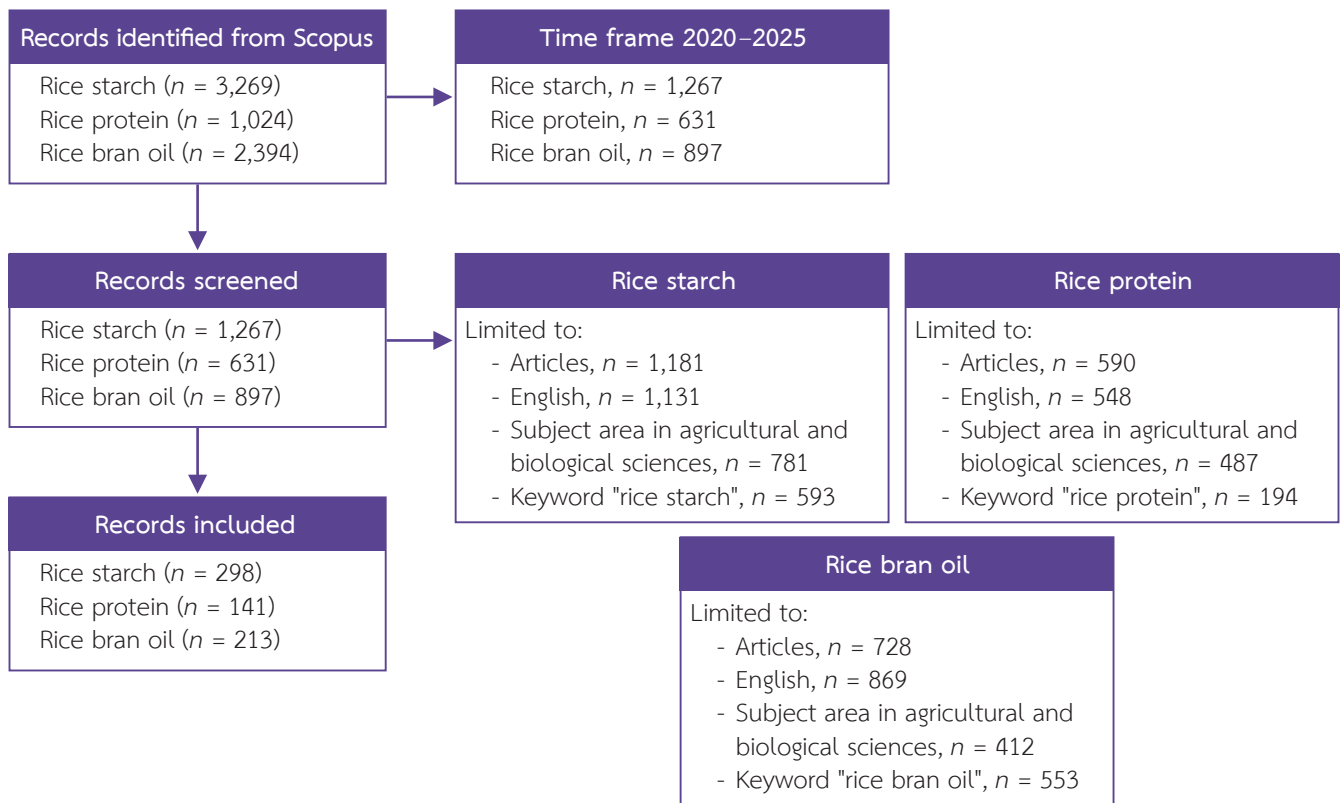
This study employed the Preferred Reporting Items for Systematic Reviews and Meta-analysis (PRISMA) framework (Page et al., 2021). The single terms for each topic “rice starch,” “rice protein,” and “rice bran oil” were used as search strings in the title, abstract, and keywords of Scopus search. To limit only current research, we applied a time frame from 2020-2025. In addition, we applied screening criteria as follows: subject area (agricultural and biological sciences), document type (article), and keyword (rice starch) for valid documents.

Bibliometric analysis is a powerful tool to study research trends in food science and technology (Cauto et al., 2024). For an ideal bibliometric study, documents

from different databases needed to be retrieved to ensure comprehensiveness (Sahrawat & Chaturvedi, 2023). However, the use of multiple databases is applicable when the volume of literature on the investigated topic is limited. In this study, only Scopus was used as we focused not only on one topic but three topics covering the major components of rice (rice starch, rice protein and rice bran oil). In addition, Scopus is the world’s largest abstract and citation database of scientific literature (Schotten et al., 2017). A large number of document records were retrieved from Scopus for each topic examined in this study. The PRISMA diagram showing the search criteria is shown in Figure 1. To ensure methodological clarity and conceptual coherence, this study adopts an analytical framework that links research objectives with bibliometric indicators, analytical tools, and expected outcomes. The framework guides the systematic mapping of rice component research through three analytical dimensions: research productivity, scholarly communication patterns, and knowledge structure. Bibliometric indicators such as publication growth, country contributions, author productivity, institutional affiliations, funding sources, journal distribution, citation patterns, and keyword co-occurrence were employed to operationalize the research objectives. Scopus analytical functions were used for descriptive bibliometric indicators, while VOSviewer software was applied to visualize knowledge structures and thematic clusters. This integrated framework enables comprehensive knowledge mapping and supports interpretation of research trends and emerging themes in rice component research.

The research workflow consists of four sequential stages. First, bibliometric data were retrieved from the Scopus database using predefined search strategies covering rice starch, rice protein, and rice bran oil publications from 2020 to early 2025. Second, data screening and cleaning were conducted following PRISMA guidelines to ensure relevance and remove duplicates. Third, bibliometric indicators were analyzed using Scopus analytical tools to examine research productivity and scholarly communication patterns. Finally, VOSviewer software was employed to perform keyword co-occurrence and author co-citation analyses for knowledge structure visualization. This workflow ensures methodological transparency, analytical rigor, and conceptual consistency in mapping the research landscape of rice components.

Figure 1
PRISMA Diagram Showing the Search Criteria



Data Analysis

The “analyze results” function in Scopus was used for data analysis and visualization. The retrieved data, which included bibliographical information such as titles, abstracts, journals, authors, institutions, publication years and keywords, were also exported from Scopus in CSV format for further analysis. The VOS viewer software was employed for creating author co-citation maps and keyword co-occurrence maps (Arruda et al. 2022; Rumangkit & Prabowo 2025).

Results and Discussion

Publication Growth

There is an increasing trend for publications on all studied rice components, as evidenced in Figure 2. Publications on rice protein have shown a sharp increase over recent years. While publications on rice starch and rice bran oils showed some drops in 2023 and 2022, respectively. Rice starch being the component that has been studied and published the most, followed by rice bran oil and rice protein. The numbers of publications reflect the utilization of rice components. The observed publication growth reflects not only increasing research activity but also industrial demand and policy-driven investment shaping the evolution of rice component research. The analytical framework guided the interpretation of bibliometric findings by linking research

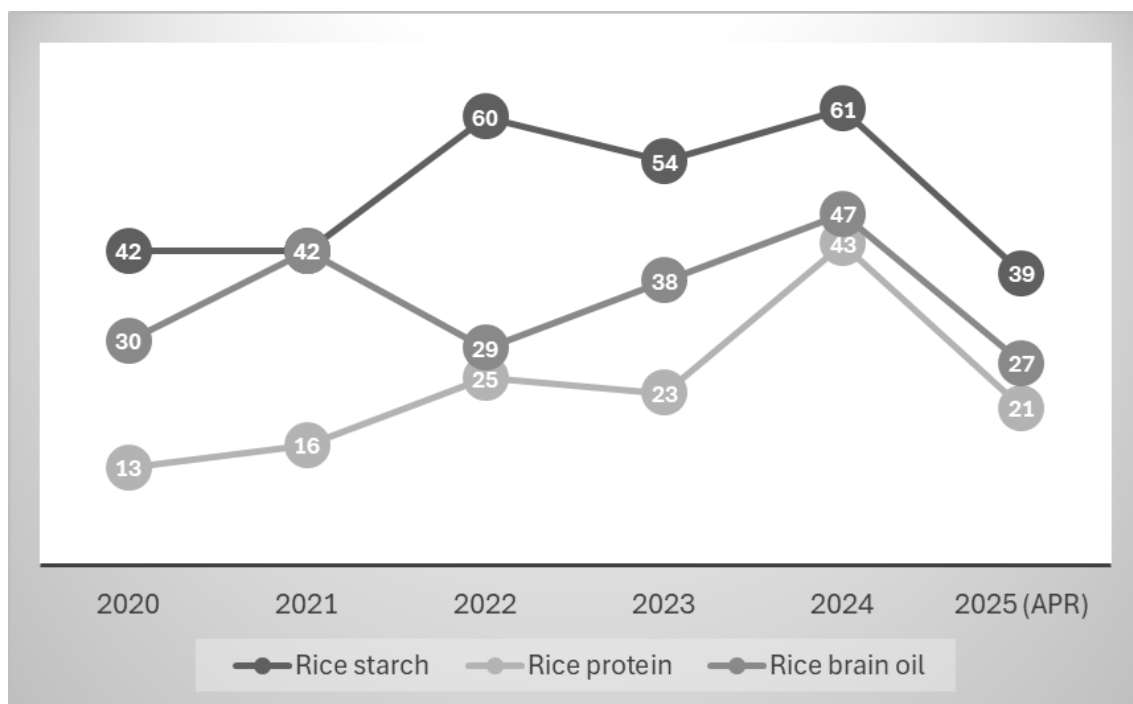
productivity, scholarly communication patterns, and knowledge structure to emerging thematic developments in rice component research.

Most rice is consumed directly as milled rice. However, many important rice products, including noodles, puffed rice, flour, and beer are also available in the markets (Bautista & Counce, 2020). The production of most rice products mainly utilizes the starch content of rice, while the utilization value of protein is relatively low (Zheng et al., 2024). Some manufacturers of glucose and monosodium glutamate use rice for sugar fermentation, and the residue after fermentation is called rice residue which contains a high amount of protein, more than 60%. Rice residue can be used for protein extraction (Likittrakulwong et al., 2021). Although rice by-products contain relatively abundant protein, in many developing countries, rice by-products, like rice bran, are not effectively used for human consumption. Rice bran contains 12–15% protein, which can provide a significant amount of protein for humans. It also contains a large amount of lipid, which accounts for 15-20%. Therefore, rice bran is mainly used to produce rice bran oil which becomes an increasingly popular vegetable oil because of its distinctive properties and nutritional values (Punia et al., 2021; Srikaeo, 2014). The rice bran after its oil removal with heat treatment is designated as heat-stabilized defatted rice bran which contains a high amount of

protein. However, heat processing during oil extraction denatures rice bran proteins, which could make the protein extraction more difficult (Zhang et al., 2012). The observed dominance of rice starch research reflects its extensive industrial utilization and technological versatility across food and non-food applications. Rice starch has long been recognized as a fundamental ingredient in food processing due to its physicochemical functionality and modification potential, which may explain its consistently higher research output compared with other rice components. In contrast, the comparatively

lower research volume on rice protein suggests technological barriers related to extraction, purification, and structural modification, despite its promising role in plant-based protein innovation. This uneven research distribution indicates that industrial demand and technological feasibility strongly influence scientific productivity across rice components. Importantly, the findings highlight rice protein as an emerging research frontier with significant potential for future interdisciplinary exploration, particularly in sustainable protein systems and alternative food development.

Figure 2
The Number of Publications From 2020–2025 (April)



Countries Contributing to Rice Research

Table 1 lists the top 10 countries, and the total number of documents retrieved from the data. China ranks first in contributing to the number of documents across all topics (rice starch, rice protein, and rice bran oil). For rice starch, the number of documents is more than eight times higher than Japan, which comes second. The trend is similar for rice protein, in which China produced 88 documents while the second country (Brazil) produced 11 documents. In terms of rice bran oil, China produced about two times more than India and Thailand, which both come second. China, Thailand, India, Brazil, and the United States are listed in the top 10 countries for all topics. Their ranking indicates that rice is the major agricultural crop and product for them (Muthayya et al. 2014). The list includes Japan for rice starch and rice bran oil, but not for rice protein. In terms of rice protein and starch, South Korea is listed, but not for rice bran oil. European countries,

including Italy, Spain, and Ireland, are listed in rice protein but not in rice starch and rice bran oil. Australia and Israel are listed in only rice starch.

Globally, more than 50% of rice is produced and consumed in China and India. The top rice-producing countries are led by China and India. The largest exporters of rice, in order, are India, Thailand, Vietnam, Pakistan, and the United States (Bautista & Counce, 2020). Rice production in China has more than tripled in recent decades, primarily due to advancements in high-yielding varieties and enhanced crop management practices (Peng et al., 2009). The finding in this study also demonstrates that China has concentrated on researching rice components, particularly rice starch (Zhu et al., 2017). These findings suggest that rice component research is strongly influenced by national agricultural priorities and resource allocation, rather than being evenly distributed across regions. The concentration of research output in

major rice-producing countries suggests a strong linkage between national agricultural priorities and scientific productivity. China’s dominance across all rice components may be attributed to sustained governmental funding, institutional research capacity, and strategic investment in rice innovation. Moreover, the presence of other Asian countries among leading contributors reflects the

socio-economic importance of rice within regional food systems. These findings indicate that research productivity in rice component studies is shaped not only by scientific interest but also by policy-driven funding and agricultural relevance, underscoring the role of national research ecosystems in knowledge development.

Table 1

Top 10 Countries and Number of Documents from the Retrieved Data

Rice starch		Rice protein		Rice bran oil	
Countries	Number	Countries	Number	Countries	Number
China	189	China	88	China	71
Japan	22	Brazil	11	India	33
Thailand	17	South Korea	10	Thailand	33
India	16	United States	8	Indonesia	16
Brazil	15	India	4	Japan	9
Australia	9	Italy	4	United States	9
South Korea	8	Spain	4	Brazil	7
United States	8	Ireland	3	Iran	7
Israel	6	Thailand	3	Egypt	6
Malaysia	6	Argentina	2	South Korea	6

Authors Contributing to Rice Research

The top 10 authors and number of documents from the retrieved data are shown in Table 2. The number of documents produced by the authors ranged from 7 to 11, 5 to 13, and 4 to 9 for rice starch, rice protein, and rice bran oil, respectively. Most authors are from China, which corresponds to countries contributing to research as explained above. Notably, the authors’ names also differ among rice starch, rice protein, and rice bran oil. Thirteen documents are the highest number from Wang, R., and Wang, T., which are in the rice protein category. This high number might be related to the rice protein being the newly investigated component when compared to rice starch and rice bran oil.

Undertaking a bibliometric analysis of research in a specific area presents challenges in assessing research

performance at the micro level, specifically for individual authors (Bornmann & Daniel, 2007). The challenges arise from two primary factors. To get statistically accurate indications, researchers must generate a substantial study output within a feasible timeframe. Secondly, the relationship between research production (i.e., publication count) and impact measured by citations is not obligatory (Wahid et al., 2022). The variation in leading authors across rice components suggests a fragmented yet specialized research landscape. This pattern may indicate that research on rice components is characterized by domain-specific expertise rather than a unified author network. Such fragmentation highlights opportunities for interdisciplinary collaboration and knowledge integration, which could accelerate innovation in rice-based product development.

Table 2
Top 10 Authors and Number of Documents From the Retrieved Data

Rice starch		Rice protein		Rice bran oil	
Authors	Number	Authors	Number	Authors	Number
Chen, L.	11	Wang, R.	13	Jin, Q.	9
Almeida, R. L. J.	9	Wang, T.	13	Yu, D.	8
He, H.	9	Feng, W.	12	Chang, M.	7
Santos, N.C.	9	Chen, Z.	8	Liu, R.	7
Zhang, N.	9	Liu, C.	7	Wang, X.	7
Corke, H.	8	Xiong, H.	7	Wang, L.	5
Sui, Z.	8	Chen, J.	6	Xu, D.	5
Zheng, B.	8	Dai, T.	6	Zhang, T.	5
Feitoza, J.V.F.	7	Mun, S.	5	Lilitchan, S.	4
Li, C.	7	Sun, Y.	5	Raharjo, S.	4

Affiliations

The affiliations along with the number of research documents produced by their researchers are illustrated in Table 3. The authors from the Ministry of Education of the People's Republic of China lead with 36 publications for rice starch. In the domain of rice protein, the authors from Jiangnan University demonstrate a dominant presence with 27 publications. Research on rice bran oil is led again by the authors from Jiangnan University, with 13 publications, followed by the authors from the Ministry of Education (10 documents) and the authors from multiple institutions with 8 publications each, such as Mahidol University, Northeast Agricultural University, Wuhan Polytechnic University, Universitas Gadjah Mada, and the Ministry of Agriculture. The information highlights the leading role of the authors from Jiangnan University and key government ministries in China in advancing

rice-related research.

Rice has been the focus of agriculture and plant research in China which is the home of both the high-yielding hybrid rice and the largest number of rice consumers. The Chinese government has strong support on rice research, with anticipated further enhancement of such support in the near future (Ma et al., 2007). The dominance of specific institutions, particularly Chinese universities and governmental research bodies, reflects institutional specialization in rice-related research. Strong collaboration between academic institutions and government agencies appears to facilitate sustained research productivity and technological advancement. This institutional concentration suggests that research infrastructure and policy alignment play critical roles in shaping the development of rice component research.

Table 3
Top 10 Affiliations and Number of Documents From the Retrieved Data

Affiliations	Number
Rice starch	
Ministry of Education of the People's Republic of China	36
Jiangnan University	21
South China University of Technology	19
Nanchang University	13
Universidade Federal de Campina Grande	9

Table 3
(continued)

Affiliations	Number
Yangzhou University	9
Harbin University of Commerce	9
Universidade Federal do Rio Grande do Norte	9
Shanghai Jiao Tong University	9
University of Shanghai for Science and Technology	8
Rice protein	
Jiangnan University	27
Nanchang University	19
Ministry of Education of the People's Republic of China	13
Changsha University of Science and Technology	8
China Agricultural University	5
Huazhong Agricultural University	5
Ministry of Agriculture of the People's Republic of China	5
University of Massachusetts Amherst	4
Nanjing University of Finance and Economics	4
Soonchunhyang University	4
Rice bran oil	
Jiangnan University	13
Ministry of Education of the People's Republic of China	10
Mahidol University	8
Northeast Agricultural University	8
Wuhan Polytechnic University	8
Universitas Gadjah Mada	8
Ministry of Agriculture of the People's Republic of China	8
South China University of Technology	7
Guangdong Academy of Agricultural Sciences	7
Kasetsart University	6

Funding Agencies

Moreover, the top 10 funding agencies and number of documents are shown in Table 4. Research on rice starch receives substantial financial backing from Chinese national agencies. The National Natural Science Foundation of China is the top contributor, supporting 113 publications, followed closely by the Ministry of Science and Technology of the People's Republic of China with 93 documents. International contributors such as the

Japan Society for the Promotion of Science and Brazil's Coordenação de Aperfeiçoamento de Pessoal de Nível Superior also appear among the top ten. The National Natural Science Foundation of China and Ministry of Science and Technology of the People's Republic of China again lead rice protein research funding, supporting 53 and 43 publications respectively. Brazilian agencies also contribute notably 9 publications. For rice bran oil, although overall publication numbers are slightly

lower, Chinese national agencies remain the top funders. A notable shift occurs with the rise of Thai research agencies such as the National Research Council of Thailand, Thailand Research Fund, Agricultural Research Development Agency, and Thailand Science Research and Innovation, collectively funding a significant portion of the research. Funding distribution reveals the influence of national research priorities in directing scientific

exploration of rice components. The prominent role of Chinese funding agencies highlights policy-driven investment in agricultural and food innovation. The findings suggest that funding concentration may shape research trajectories and thematic emphasis, emphasizing the importance of strategic investment in emerging areas such as rice protein and sustainable processing technologies.

Table 4

Top 10 Funding Agencies and Number of Documents From the Retrieved Data

Funding agencies	Number
Rice starch	
National Natural Science Foundation of China	113
Ministry of Science and Technology of the People's Republic of China	93
National Key Research and Development Program of China	39
China Postdoctoral Science Foundation	14
Fundamental Research Funds for the Central Universities (China)	11
Japan Society for the Promotion of Science	11
Coordenação de Aperfeiçoamento de Pessoal de Nível Superior (Brazil)	10
Guangdong Provincial Department of Science and Technology	9
Ministry of Education of the People's Republic of China	9
Ministry of Finance (China)	8
Rice protein	
National Natural Science Foundation of China	53
Ministry of Science and Technology of the People's Republic of China	43
Fundamental Research Funds for the Central Universities	11
Ministry of Education of the People's Republic of China	11
Ministry of Finance	10
Conselho Nacional de Desenvolvimento Científico e Tecnológico	9
Coordenação de Aperfeiçoamento de Pessoal de Nível Superior	9
Jiangsu Provincial Department of Science and Technology	9
Nanchang University	9
National Key Research and Development Program of China	8
Rice bran oil	
National Natural Science Foundation of China	33
Ministry of Science and Technology of the People's Republic of China	24
National Key Research and Development Program of China	8
National Research Council of Thailand	7
Thailand Research Fund	6

Table 4
(continued)

Funding agencies	Number
Agricultural Research Development Agency	5
Conselho Nacional de Desenvolvimento Científico e Tecnológico	4
Fundação para a Ciência e a Tecnologia	4
Kasetsart University	4
Thailand Science Research and Innovation	4

Journals

Table 5 shows the journals that published research articles on rice components based on the retrieved data. For rice starch, Food Hydrocolloids (61 documents) and Food Chemistry (42 documents) were the leading journals publishing related studies. Research on rice protein was also prominent in Food Chemistry (29 documents) and Food Hydrocolloids (21 documents), while investigations into rice bran oil were frequently published in Food Chemistry (27 documents) and LWT (21 documents). Other journals, including Food Research International, International Journal of Food Science and Technology, and Foods, also contributed notable numbers of publications across all three rice components. Among the journals publishing research on rice starch, rice protein, and rice bran oil, many are from Elsevier, including Food Hydrocolloids, Food Chemistry, LWT, Food Research International, Innovative Food Science and Emerging Technologies, and Food Bioscience. Elsevier journals contributed a substantial share of the total articles. In

contrast, journals from other publishers, such as International Journal of Food Science and Technology (a journal from Institute of Food Science and Technology), Journal of Agricultural and Food Chemistry (ACS Publications), and Journal of Food Science and Technology (Springer), also made notable contributions but to a lesser extent. This reflects Elsevier's dominant role in disseminating rice-related food research compared to other major publishing companies. This concentration of publications within a limited group of publishers may shape citation patterns and influence the visibility of rice component research in the global knowledge ecosystem. The concentration of publications within a limited number of journals, particularly those published by major scientific publishers, indicates potential influences on knowledge visibility and citation patterns. Such publishing concentration may contribute to the formation of dominant research narratives and affect the global dissemination of rice component knowledge.

Table 5
Top 10 Journals and Number of Documents From the Retrieved Data

Journal names	Number
Rice starch	
Food Hydrocolloids	61
Food Chemistry	42
Starch	27
LWT	19
International Journal of Food Science and Technology	15
Food Research International	13
Foods	13
Innovative Food Science and Emerging Technologies	8

Table 5
(continued)

Journal names	Number
Journal of Cereal Science	8
Food Bioscience	7
Rice protein	
Food Chemistry	29
Food Hydrocolloids	21
Food Research International	20
LWT	15
International Journal of Food Science and Technology	11
Journal of Agricultural and Food Chemistry	6
Food Biophysics	4
Food Science and Biotechnology	4
Food and Function	3
Food Bioscience	3
Rice bran oil	
Food Chemistry	27
LWT	21
Food Research	13
International Journal of Food Science and Technology	12
Journal of Food Science and Technology	8
Food Research International	6
Food Hydrocolloids	5
Foods	5
Journal of Food Composition and Analysis	5
Food and Bioprocess Technology	4

Citation Analysis

The top 10 citations, 2022-2025 (April), of the documents from the retrieved data are listed in Table 6. Highly cited articles related to rice research focus on the structural and functional properties of rice components. For rice starch, influential studies have explored the physicochemical interactions with other biopolymers, structural modifications through treatments like microwave and cold plasma, and the effects on digestibility and stability. In rice protein, highly cited works emphasize the development of meat analogues, functional improvements via enzymatic hydrolysis, and the impact of rice protein interactions on starch digestibility and 3D

food printing. Regarding rice bran oil, the most cited articles concentrate on improving oxidative stability, enhancing storage conditions, and characterizing physicochemical and bioactive properties, including the use of oleo-gelation and antioxidant interaction studies. These high-impact studies highlight the broad interest in improving the functionality and application of rice components in food systems.

The number of citations an article receives, and the studies cited in an article are two of the most popular bibliometric indicators used to determine an article's quality (Levitt & Thelwall, 2011). Nevertheless, the number of citations received by an article may owe to the popularity

of the article's author or research field rather than the relevance of the article itself (Rey-Martí et al., 2016). Highly cited studies predominantly focus on functional and structural properties of rice components, highlighting the central role of technological and application-driven

research. This citation pattern suggests that research impact within rice component studies is closely associated with functional innovation and practical applicability in food systems.

Table 6

Top 10 Citations, 2022-2025 (April), of the Documents From the Retrieved Data

	Titles	Year	Journals	Citations
Rice starch				
1.	Physicochemical characterization of rice, potato, and pea starches, each with different crystalline pattern, when incorporated with Konjac glucomannan	2020	Food Hydrocolloids	118
2.	Starch granule-associated proteins affect the physicochemical properties of rice starch	2020	Food Hydrocolloids	117
3.	Modification of multi-scale structure, physicochemical properties, and digestibility of rice starch via microwave and cold plasma treatments	2022	LWT	101
4.	Inhibition from whey protein hydrolysate on the retrogradation of gelatinized rice starch	2020	Food Hydrocolloids	108
5.	Physicochemical interactions between rice starch and different polyphenols and structural characterization of their complexes	2020	LWT	159
6.	Encapsulation of lycopene in emulsions and hydrogel beads using dual modified rice starch: Characterization, stability analysis and release behaviour during in-vitro digestion	2020	Food Hydrocolloids	113
7.	Investigation of structural and physico-chemical properties of rice starch with varied amylose content: A combined microscopy, spectroscopy, and thermal study	2022	Food Hydrocolloids	111
8.	Improving the in vitro digestibility of rice starch by thermomechanically assisted complexation with guar gum	2020	Food Hydrocolloids	108
9.	Pasting behaviors, gel rheological properties, and freeze-thaw stability of rice flour and starch modified by green tea polyphenols	2020	LWT	96
10.	An insight into starch slowly digestible features enhanced by microwave treatment	2020	Food Hydrocolloids	98
Rice protein				
1.	Physico-chemical characteristics of rice protein-based novel textured vegetable proteins as meat analogues produced by low-moisture extrusion cooking technology	2022	LWT	102
2.	Effect of natural fermentation on milled rice grains: Physicochemical and functional properties of rice flour	2020	Food Hydrocolloids	57
3.	Gel properties of rice proteins-pectin composite and the delivery potential for curcumin: Based on different concentrations and the degree of esterification of pectin	2024	Food Hydrocolloids	52
4.	Improvement of the functional and antioxidant properties of rice protein by enzymatic hydrolysis for the microencapsulation of linseed oil	2020	Journal of Food Engineering	94
5.	Characterization of rice glutelin fibrils and their effect on in vitro rice starch digestibility	2020	Food Hydrocolloids	64

Table 6
(continued)

Titles	Year	Journals	Citations
6. Construction of 3D printed meat analogs from plant-based proteins: Improving the printing performance of soy protein- and gluten-based pastes facilitated by rice protein	2023	Food Research International	61
7. Functional properties and structural changes of rice proteins with anthocyanins complexation	2020	Food Chemistry	117
8. Effect of amino acids composing rice protein on rice starch digestibility	2021	LWT	55
9. Protein structural properties and proteomic analysis of rice during storage at different temperatures	2021	Food Chemistry	58
10. Effects of protein concentration during ultrasonic processing on physicochemical properties and techno-functionality of plant food proteins	2021	Food Hydrocolloids	52
Rice bran oil			
1. Effect of washing, soaking and pH in combination with ultrasound on enzymatic rancidity, phytic acid, heavy metals and coliforms of rice bran	2021	Food Chemistry	47
2. Optimization and characterization of new oleogels developed based on sesame oil and rice bran oil	2023	Food Hydrocolloids	33
3. Fabrication and characterization of the W/O/W multiple emulsion through oleogelation of oil	2021	Food Chemistry	35
4. Evaluation and improvement of storage stability of astaxanthin isomers in oils and fats	2021	Food Chemistry	37
5. Antioxidant interaction of α -tocopherol, γ -oryzanol and phytosterol in rice bran oil	2021	Food Chemistry	89
6. Physicochemical properties, fatty acid compositions, bioactive compounds, antioxidant activity and thermal behavior of rice bran oil obtained with aqueous enzymatic extraction	2021	LWT	63
7. A reconsidered approach providing kinetic parameters and rate constants to analyze the oxidative stability of bulk lipid systems	2020	Food Chemistry	36
8. Detection of camellia oil adulteration using chemometrics based on fatty acids GC fingerprints and phytosterols GC-MS fingerprints	2021	Food Chemistry	75
9. Determination and health risk assessment of heavy metals in imported rice bran oil in Iran	2020	Journal of Food Composition and Analysis	42
10. Effect of fatty acid composition of vegetable oils on crystallization and gelation kinetics of oleogels based on natural wax	2022	Food Chemistry	36

In addition, we performed author co-citation analysis which is used to identify, trace, and visualize the intellectual structure of an academic discipline by counting the frequency with which any work of an author is co-cited with another author in the references of citing documents (Bayer et al., 1990). The minimum threshold of 30 citations were applied for all three topics. The author co-citation maps are shown in Figure 3.

For rice starch, Figure 3(a), from 19,943 authors, 262 met the criteria. There are 5 clusters of the authors. Chen, L. was the utmost productive author with 435 citations (TLS = 35,163), followed by Li, C. with 315 citations (TLS = 26,242). For rice protein, Figure 3(a), from 13,725 authors, 78 met the criteria. There are 5 clusters of the authors. Wang, T. was the utmost productive author with 158 citations (TLS = 8,022), followed by

Wang, L. with 156 citations (TLS = 7,886). In terms of rice bran oil, Figure 3(a), 42 of 20,705 authors met the criteria. There are 3 clusters of authors. The utmost productive

authors was Wang, X. with 163 citations (TLS =3,065), followed by Wang, Y. with 108 citations (TLS = 1,916).

Figure 3

Author Co-citation Maps for (a) Rice Starch, (b) Rice Protein, and (c) Rice Bran Oil

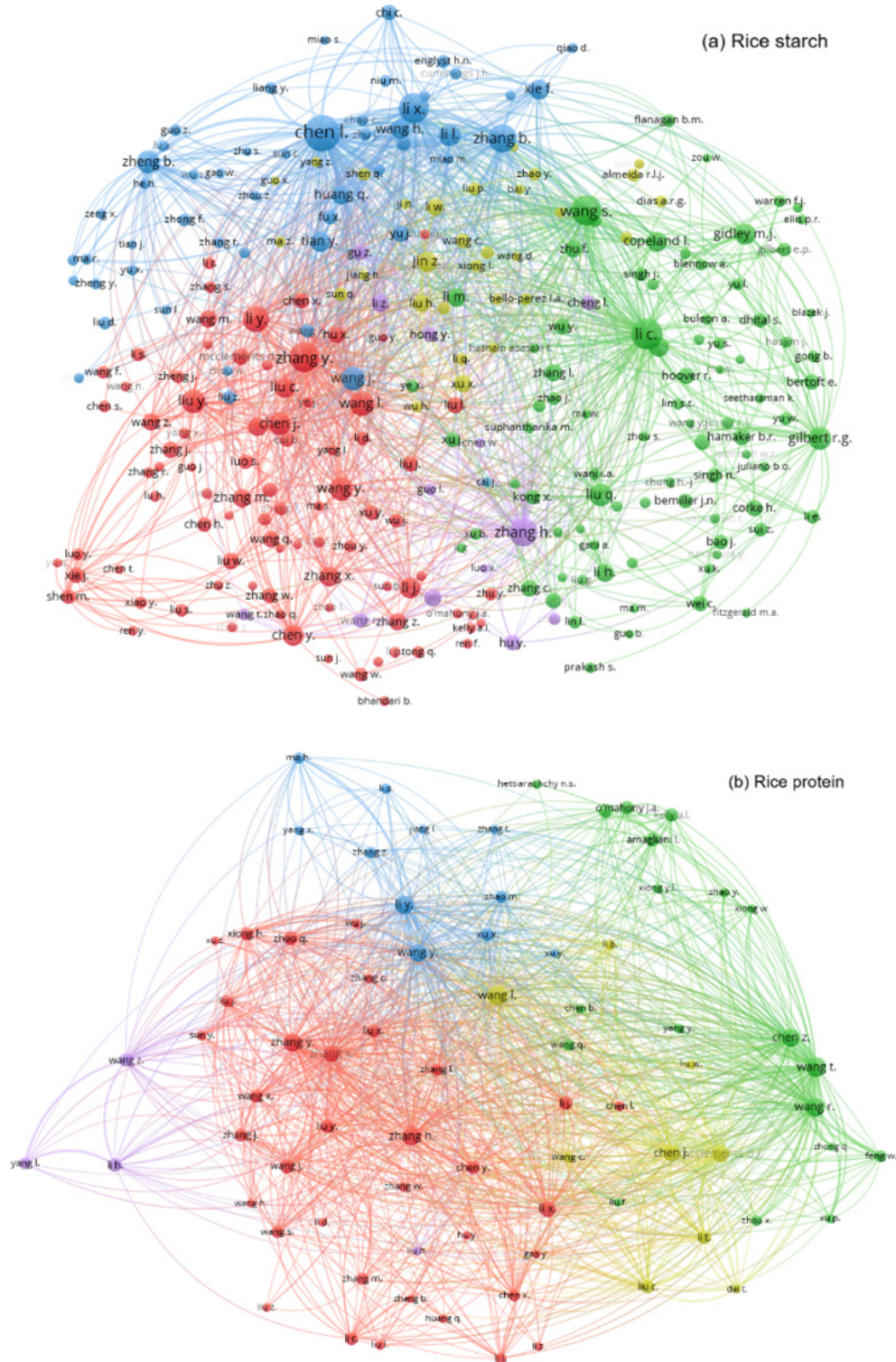
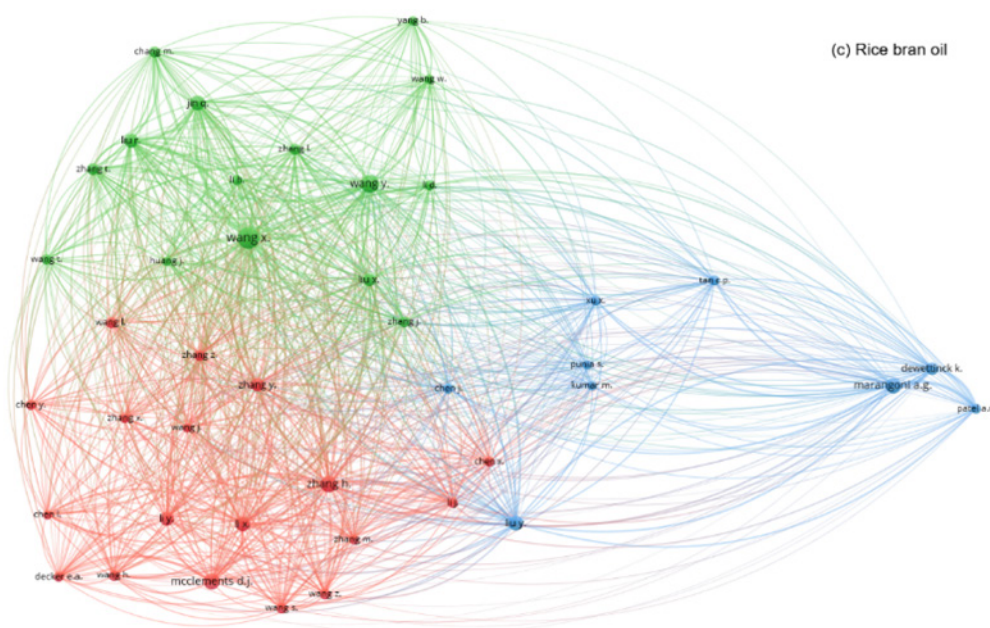


Figure 3
(continued)



Keywords Analysis

The co-occurrence of keywords that appeared extensively in the articles, as visualized by VOS viewer software, is shown in Figure 4. The co-occurrence map revealed patterns of frequency and relationship among the keywords/topics. The size of keyword nodes on the map signifies the relative frequency (i.e., level of interest) of a topic discussed in the documents. The positions, links, and proximity between keyword nodes visualize the relatedness of topics studied in literature. The lines or links between nodes indicate that the two keywords co-occurred; the density of the lines suggests the frequency of co-occurrence. The proximity of nodes on the map suggests the degree to which nodes were related in the literature. Finally, the software organized the keywords into colored clusters, which suggest broad conceptual similarity among the keywords (Narong & Hallinger, 2023; Sumarsono et al., 2025).

The co-occurrence of keywords from rice starch topic is illustrated in Figure 4(a). For this topic, we applied a threshold of at least 10 occurrences of a keyword (at least 10 times of the keywords get repeated across the searched articles). From 2,500 keywords, 82 keywords met the criteria. Based on the total link strength (TLS), rice starch, starch and chemistry were found to be the top 3 with highest TLS scores. The keywords were classified into 4 clusters and illustrated by different colors. The red color consists of 26 keywords which include keywords such as chemistry, Oryza, rice, gelatinization, Fourier transform infrared spectroscopy, etc. The green cluster consists of 20 keywords such as rice starch, starch, hydrogen bonds, rheology, etc. The cyan color consists of 18 keywords such as digestion, hydrolysis, particle size, resistant starch,

glycemic index, etc. The yellow cluster also consists of 18 keywords such as gelation, crystallinity, physicochemical properties, cyclodextrins, etc.

The co-occurrence of keywords from rice protein topic is illustrated in Figure 4(b). For this topic, we applied the same criteria as rice starch. From 1,851 keywords, 54 keywords met the criteria. Rice proteins, proteins and Oryza were the top 3 keywords with the highest TLS scores. A total of 5 clusters were classified in the map. The red color consists of 19 keywords such as plant protein, Oryza, antioxidant, chemistry, metabolism, digestion, etc. The green color consists of 14 keywords such as rice protein, protein, functional properties, physicochemical property, starch, Fourier transform infrared spectroscopy. The cyan color consists of 11 keywords such as hydrophobicity, protein structure, nonhuman, etc. The yellow color consists of 9 keywords such as emulsification, solubility, particle size, protein isolate, Ostwald ripening, etc. Notably that the purple cluster consists of only one keyword which is pea protein, and it links to all the other clusters.

For rice bran oil, the co-occurrence of keywords is shown in Figure 4(c). Using the same criteria, 57 keywords from 2,552 keywords met the criteria. They were classified into 5 clusters. The red color consisted of 16 keywords with “rice bran oil” being the strongest TLS. The green color consists of 15 keywords such as vegetable oil, plant oil, unclassified drug, triacylglycerol, etc. The cyan color consists of 13 keywords including rice bran, emulsification, moisture, extraction, controlled study, nonhuman, etc. The yellow color consists of 8 keywords such as fatty acid, oleo-gel, oxidative stability, etc. The purple color consists of 5 keywords such as chemistry,

Conclusions

This bibliometric analysis highlights the dynamic and evolving landscape of rice research, focusing on three major components: rice starch, rice protein, and rice bran oil. A significant increase in research output was observed between 2020 and 2025, reflecting growing scientific and industrial interest in rice component utilization. Rice starch remains the most extensively studied component, followed by rice bran oil and rice protein. China overwhelmingly leads global contributions in terms of publications, authorship, institutional affiliations, and funding support, underscoring the influence of national research investment and policy priorities on shaping the global rice research landscape. The analysis further reveals that highly cited works are primarily centered on improving the structural, functional, and nutritional qualities of rice components for application in modern food systems. Future research directions identified in this study underscore the importance of interdisciplinary collaboration, sustainable processing strategies, and value-added utilization of rice byproducts. Bibliometric analysis proved to be an effective tool for mapping rice research with a particular focus on major rice components, and the integrated analytical framework adopted in this study provides methodological value for knowledge mapping across food innovation and agricultural research domains. This approach may also be extended to other food components to support strategic research planning and innovation development.

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Author Contributions

Janya Thonabut: Writing – review & editing, Data curation, Formal analysis, Visualization, Validation. **Jiraphat Kaewsritong:** Writing – review & editing, Data curation, Validation. **Khongsak Srikaeo:** Writing – original draft, Conceptualization, Methodology, Data curation, Formal analysis, Visualization, Supervision, Project administration, Funding acquisition.

Declaration of Competing Interest

The authors declare that they have no known competing financial or personal interests that could have appeared to influence the work reported in this paper.

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References

- Al-Doury, M. K. W., Hettiarachchy, N. S., & Horax, R. (2018). Rice-endosperm and rice-bran proteins: a review. *Journal of the American Oil Chemists' Society*, 95(8), 943–956. <https://doi.org/10.1002/aocs.12110>
- Arruda, H., Silva, E. R., Lessa, M., Proença Jr, D., & Bartholo, R. (2022). VOSviewer and bibliometrix. *Journal of the Medical Library Association*, 110(3), 392–395. <https://doi.org/10.5195/jmla.2022.1434>
- Bautista, R. C., & Counce, P. A. (2020). An overview of rice and rice quality. *Cereal Foods World*, 65(5), Article 52. <https://doi.org/10.1094/CFW-65-5-0052>
- Bayer, A. E., Smart, J. C., & McLaughlin, G. W. (1990). Mapping intellectual structure of a scientific subfield through author cocitations. *Journal of the American Society for Information Science*, 41(6), 444–452. [https://doi.org/10.1002/\(SICI\)1097-4571\(199009\)41:6<444::AID-AS112>3.0.CO;2-J](https://doi.org/10.1002/(SICI)1097-4571(199009)41:6<444::AID-AS112>3.0.CO;2-J)
- Bin Rahman, A. N. M. R., & Zhang, J. (2023). Trends in rice research: 2030 and beyond. *Food and Energy Security*, 12(2), Article e390. <https://doi.org/10.1002/fes3.390>
- Bormann, L., & Daniel, H. (2007). What do we know about the h index? *Journal of the American Society for Information Science and Technology*, 58(9), 1381–1385. <https://doi.org/10.1002/asi.20609>
- Cauto, A., Castello, M. L., & Ortolá, M. D. (2024). Moringa oleifera pods: Bibliometric analysis, properties, and food technology applications. *Journal of Food Technology Research*, 11(2), 49–61. <https://doi.org/10.18488/jftr.v11i2.3784>
- Donthu, N., Kumar, S., Mukherjee, D., Pandey, N., & Lim, W. M. (2021). How to conduct a bibliometric analysis: An overview and guidelines. *Journal of Business Research*, 133, 285–296. <https://doi.org/10.1016/j.jbusres.2021.04.070>
- Ellegaard, O., & Wallin, J. A. (2015). The bibliometric analysis of scholarly production: How great is the impact? *Scientometrics*, 105(3), 1809–1831. <https://doi.org/10.1007/s11192-015-1645-z>
- Fraterrigo Garofalo, S., Tommasi, T., & Fino, D. (2021). A short review of green extraction technologies for rice bran oil. *Biomass Conversion and Biorefinery*, 11, 569–587. <https://doi.org/10.1007/s13399-020-00846-3>
- Fukagawa, N. K., & Ziska, L. H. (2019). Rice: Importance for global nutrition. *Journal of Nutritional Science and Vitaminology*, 65(Supplement), S2–S3. <https://doi.org/10.3177/jnsv.65.S2>
- Levitt, J. M., & Thelwall, M. (2011). A combined bibliometric indicator to predict article impact. *Information Processing & Management*, 47(2), 300–308. <https://doi.org/10.1016/j.ipm.2010.09.005>
- Likittrakulwong, W., Poolprasert, P., & Srikaeo, K. (2021). Effects of extraction methods on protein properties obtained from paddy rice and germinated paddy rice. *PeerJ*, 9, Article e11365. <https://doi.org/10.7717/peerj.11365>
- Ma, H., Chong, K., & Deng, X.-W. (2007). Rice research: past, present and future. *Journal of Integrative Plant Biology*, 49(6), 729–730. <https://doi.org/10.1111/j.1744-7909.2007.00515.x>
- Muthayya, S., Sugimoto, J. D., Montgomery, S., & Maberly, G. F. (2014). An overview of global rice production, supply, trade, and consumption. *Annals of the New York Academy of Sciences*, 1324(1), 7–14. <https://doi.org/10.1111/nyas.12540>
- Narong, D. K., & Hallinger, P. (2023). A keyword co-occurrence analysis of research on service learning: conceptual foci and emerging research trends. *Education Sciences*, 13(4), Article 339. <https://doi.org/10.3390/educsci13040339>
- Page, M. J., McKenzie, J. E., Bossuyt, P. M., Boutron, I., Hoffmann, T. C., Mulrow, C. D., Shamseer, L., Tetzlaff, J. M., Akl, E. A., Brennan, S. E., Chou, R., Glanville, J., Grimshaw, J. M., Hróbjartsson, A., Lalu, M. M., Li, T., Loder, E. W., Mayo-Wilson, E., McDonald, S., McGuinness, L. A., Stewart, L. A., Thomas, J., Tricco, A. C., Welch, V. A., Whiting, P., & Moher, D. (2021). The PRISMA 2020 statement: an updated guideline for reporting systematic reviews. *BMJ*, 372, n71. <https://doi.org/10.1136/bmj.n71>

- Park, B.-R., No, J., Oh, H., Park, C. S., You, K.-M., & Chewaka, L. S. (2025). Exploring puffed rice as a novel ink for 3D food printing: Rheological characterization and printability analysis. *Journal of Food Engineering*, 387, Article 112313. <https://doi.org/10.1016/j.jfoodeng.2024.112313>
- Peng, S., Tang, Q., & Zou, Y. (2009). Current status and challenges of rice production in China. *Plant Production Science*, 12(1), 3–8. <https://doi.org/10.1626/ppls.12.3>
- Punia, S., Kumar, M., Sandhu, K. S., & Whiteside, W. S. (2021). Rice-bran oil: An emerging source of functional oil. *Journal of Food Processing and Preservation*, 45(4), Article e15318. <https://doi.org/10.1111/jfpp.15318>
- Rey-Martí, A., Ribeiro-Soriano, D., & Palacios-Marqués, D. (2016). A bibliometric analysis of social entrepreneurship. *Journal of Business Research*, 69(5), 1651–1655. <https://doi.org/10.1016/j.jbusres.2015.10.033>
- Rumangkit, S., & Prabowo, H. (2025). Global trends and future research resources-based view theory in management science through a scoping review and bibliometric analysis. *Multidisciplinary Reviews*, 8(1), Article 2025013. <https://doi.org/10.31893/multirev.2025013>
- Sahrawat, N., & Chaturvedi, N. (2023). A bibliometric analysis of research on stability of functional beverages by use of hydrocolloids using VOSviewer mapping analysis computations. *Annals of Library and Information Studies*, 71(2), 226–234. <https://doi.org/10.56042/alis.v71i2.7615>
- Samaddar, A., Azam, M. M., Singaravadevel, K., Venkatachalapathy, N., Swain, B. B., & Mishra, P. (2017). Postharvest management and value addition of rice and its by-products. In S. Mohanty, P. G. Chengappa, Mruthyunjaya, J.K. Ladha, S. Baruah, E. Kannan, A.V. Manjunatha (Eds), *The Future Rice Strategy for India* (pp. 301–34). Academic Press. <https://doi.org/10.1016/B978-0-12-805374-4.00011-7>
- Schotten, M., el Aisati, M., Meester, W. J. N., Steinging, S., & Ross, C. A. (2017). A brief history of Scopus: The world's largest abstract and citation database of scientific literature. In F. J. Cantu-Ortiz (Ed.), *Research Analytics* (pp. 31–58). Auerbach Publications. <https://doi.org/10.1201/9781315155890>
- Shukla, S. S., Chava, R., Appari, S., Bahurudeen, A., & Kuncharam, B. V. R. (2022). Sustainable use of rice husk for the cleaner production of value-added products. *Journal of Environmental Chemical Engineering*, 10(1), Article 106899. <https://doi.org/10.1016/j.jece.2021.106899>
- Singh, P., Sundaram, K. T., Vinukonda, V. P., Venkateshwarlu, C., Paul, P. J., Pahi, B., Gurjar, A., Singh, U. M., Kalia, S., Kumar, A., Singh V. K., & Sinha, P. (2024). Superior haplotypes of key drought-responsive genes reveal opportunities for the development of climate-resilient rice varieties. *Communications Biology*, 7, Article 89. <https://doi.org/10.1038/s42003-024-05769-7>
- Srikaeo, K. (2014). Organic rice bran oils in health. In R. R. Watson, V. R. Preedy, & S. Zibadi (Eds), *Wheat and Rice in Disease Prevention and Health* (pp. 453–65). Academic Press. <https://doi.org/10.1016/B978-0-12-401716-0.00035-0>
- Srikaeo, K. (2022). Cereal grain-based milks and their potential health properties. In S. P. Bangar, & A. K. Siroha (Eds), *Functional Cereals and Cereal Foods: Properties, Functionality and Applications* (pp. 251–88). Springer. https://doi.org/10.1007/978-3-031-05611-6_10
- Sumarsono, H., Narmaditya, B. S., Rahmawati, F., Prayitno, P. H., & Sahid, S. (2025). Green marketing for sustainability business: A bibliometric analysis. *Multidisciplinary Reviews*, 8(3), Article 2025078. <https://doi.org/10.31893/multirev.2025078>
- Sundaram, R. M., Sanjeeva Rao, D., Sanghamitra, P., Spoorti, S. G., Veerendra, J., Siromani, N., Niharika, G., Ananthan, R., Aravind Kumar, J., Raghuvveer Rao, P., Malathi, S., Mangrauthai, S. K., Balram, M., Ali, J., & Neeraja, C. N. (2023). Redesigning rice as a Promising Nutraceutical Functional Food. In C. Kole (Ed), *Compendium of crop genome designing for nutraceuticals* (pp. 1–58). Springer. https://doi.org/10.1007/978-981-19-3627-2_1-1
- Van Eck, N. J., & Waltman, L. (2014). Visualizing bibliometric networks. In Y. Ding, R. Rousseau, & D. Wolfram (Eds.), *Measuring scholarly impact: Methods and practice* (pp. 285–320). Springer. https://doi.org/10.1007/978-3-319-10377-8_13
- Wahid, N., Warraich, N. F., & Tahira, M. (2022). Factors influencing scholarly publication productivity: a systematic review. *Information Discovery and Delivery*, 50(1), 22–33. <https://doi.org/10.1108/IDD-04-2020-0036>
- Zeigler, R. S., & Barclay, A. (2008). The relevance of rice. *Rice*, 1, 3–10. <https://doi.org/10.1007/s12284-008-9001-z>
- Zhang, H. -J., Zhang, H., Wang, L., & Guo, X. -N. (2012). Preparation and functional properties of rice bran proteins from heat-stabilized defatted rice bran. *Food Research International*, 47(2), 359–363. <https://doi.org/10.1016/j.foodres.2011.08.014>
- Zheng, L., San, Y., Xing, Y., & Regenstein, J. M. (2024). Rice proteins: A review of their extraction, modification techniques and applications. *International Journal of Biological Macromolecules*, 268, Article 131705. <https://doi.org/10.1016/j.ijbiomac.2024.131705>
- Zhu, D., Zhang, H., Guo, B., Xu, K., Dai, Q., Wei, C., Zhou, G., & Huo, Z. (2017). Physicochemical properties of indica-japonica hybrid rice starch from Chinese varieties. *Food Hydrocolloids*, 63, 356–363. <https://doi.org/10.1016/j.foodhyd.2016.09.013>
- Zupic, I., & Čater, T. (2015). Bibliometric methods in management and organization. *Organizational Research Methods*, 18(3), 429–472. <https://doi.org/10.1177/1094428114562629>