Visual Analysis of the Knowledge Graph Depicting Research Progress on the Medicinal and Edible Traditional Chinese Medicine Huangjing Using CiteSpace

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Abstract [**Objectives**] To analyze the research progress and identify the key areas of focus concerning Huangjing, a traditional Chinese medicine recognized for its dual use as both an edible and medicinal substance. [**Methods**] The relevant literature of Huangjing from 2015 to 2025 was retrieved from the CNKI and WOS databases. CiteSpace 6.3.1 was employed to perform a visual analysis of the number of published articles, authors, institutions, and keywords. [**Results**] A total of 2 827 articles in Chinese and 264 articles in English were included in the analysis. The number of articles published in both Chinese and English has increased annually. Chinese-language articles have primarily focused on traditional Chinese pharmacology and crop sciences, emphasizing key areas such as Huangjing polysaccharides, chemical constituents, and anti-tumor properties. In contrast, English-language articles have predominantly concentrated on molecular mechanisms, including gene expression, apoptosis, and intestinal microbiota. Collaborative efforts among authors and institutions exhibit distinct clustering patterns and cross-regional characteristics. [**Conclusions**] Research on Huangjing has progressed rapidly. Studies conducted in both Chinese and English complement each other with respect to key topics and research directions. Moving forward, it is essential to enhance the understanding of underlying mechanisms, establish standardized protocols, and promote international collaboration.

Key words Huangjing, CiteSpace, Visual analysis, Knowledge graph

1 Introduction

The principle that food and medicine share a common origin is a fundamental concept in traditional Chinese health preservation culture and its medical system. Certain medicinal substances exhibit dual characteristics, functioning both as nutritional sustenance and as therapeutic agents. These substances not only meet safety criteria for daily consumption but also contribute to preventive healthcare and serve as complementary treatments due to their medicinal properties. The origin of this concept dates back to ancient times, when early humans, in their quest for sustenance, gradually realized that certain foods could alleviate physical discomfort beyond merely satisfying hunger. This realization marked the initial comprehension that food and medicine share a common origin. As traditional Chinese medicine progressed, this concept underwent further refinement and expansion. The *Huangdi Neijing* (Yellow Emperor's Inner Canon) emphasizes the importance of combining pharmacological interventions with dietary adjustments, asserting that medicine should be employed to eradicate the condition, followed by appropriate dietary measures. In recent years, driven by China's health policies and measures, there has been significant advancement in the development of food and medicinal ingredients sharing common origins, especially in the field of functional foods and medicinal diets. Consequently, medicinal dietary products have shifted from their traditional role within family meals to standardized and industrialized forms, thereby effectively meeting consumers' daily healthcare requirements[1-2].

The 2025 edition of the *Pharmacopoeia of the People's Republic of China* includes various Huangjing species, including *Polygonatum kingianum* Coll. et Hemsl., *Polygonatum sibiricum* Red., and *Polygonatum cyrtonema* Hua. In addition to its traditional applications, modern research highlights its rich content of active compounds like saponins, flavonoids, polysaccharides, and alkaloids. These constituents contribute to a wide range of health benefits, including anti-inflammatory, anti-tumor, anti-aging, antioxidant, hypoglycemic, and immunomodulatory properties[3]. Additionally, Huangjing powder, extracts with varying polarities, and polysaccharides exhibit notable health-protective effects[4]. This paper utilizes CiteSpace 6.3.1 software developed by Professor Chen Chaomei, which is based on bibliometric principles and data visualization techniques implemented in the Java programming language, to conduct a visual graph analysis of authors, institutions, keywords, and the annual publication count in research pertaining to Huangjing from 2015 to 2025. This analysis aims to explore the latest research trends and hotspots associated with Huangjing.

2 Materials and methods

2.1 Sources of literature The China National Knowledge Infrastructure (CNKI) served as the source for Chinese literature

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data, while the Web of Science Core Collection Database (WOS) provided the English literature data. Relevant literature on the research of the traditional Chinese medicine Huangjing published over the past decade was selected, with the search period spanning from January 1, 2016, to October 5, 2025.

The literature search in Chinese was conducted using the subject term "Huangjing", with academic journals specified as the literature type. A total of 2 934 pieces of literature were retrieved. The literature search in English was conducted with the subject terms TS = (*Polygonatum kingianum*) OR TS = (*Polygonatum cyrtonema* Hua) OR TS = (*Polygonatum sibiricum* Red). The literature type was selected as "Article or Review", resulting in the retrieval of a total of 370 pieces of literature. Following the selection process and the exclusion of irrelevant reports and literature without authorship, a total of 2 827 valid pieces of Chinese-language literature and 264 valid pieces of English-language literature were finally obtained.

2.2 Data processing The Chinese-language literature in "Refworks" format and the English-language literature in "plain text" format were exported, renaming the files as "CNKI - **.txt" and "download - **.txt", respectively. These exported files were then converted into a data format compatible with CiteSpace 6.3.1 for subsequent analysis.

The parameters were configured for time slicing, spanning from January 2016 to October 2025. The temporal resolution was set to one year per slice, and the node types included authors, institutions, and keywords. The proportional coefficient (k) was assigned values of 10 and 25, while the maximum number of items per slice was fixed at 50. A visual analysis of different types of nodes was conducted separately. In this analysis, the size of each node and the font represent the frequency of the node's occurrence, while the connection line between nodes indicates the cooperative relationship between them. Furthermore, the thickness of the connection line corresponds to the strength of the cooperation.

3 Results and analysis

3.1 Analysis of trends and distribution of publications As shown in Fig. 1, the total number of published Chinese-language articles had exhibited a consistent upward trend, rising from 138 articles in 2016 to a peak of 401 articles in 2024. Although a slight decline occurred in 2025, the total remained relatively high at 346 articles as of October 5, 2025. In contrast, the total number of published English-language articles was comparatively low; however, it exhibited a gradual upward trend, starting with 3 articles in 2016, increasing to 8 articles in 2019, and continuing to rise annually, reaching approximately 77 articles in 2024, before stabilizing at 67 articles in 2025 (as of October 5, 2025).

As shown in Fig. 2, research on Huangjing within the CNKI database indicates a significant disciplinary concentration, characterized by a dual-core leadership structure and the integration of multiple disciplines. The combined proportion of literature in the two primary disciplines—traditional Chinese medicine (38%) and crops (28%)—accounts for 66%, surpassing two-thirds of

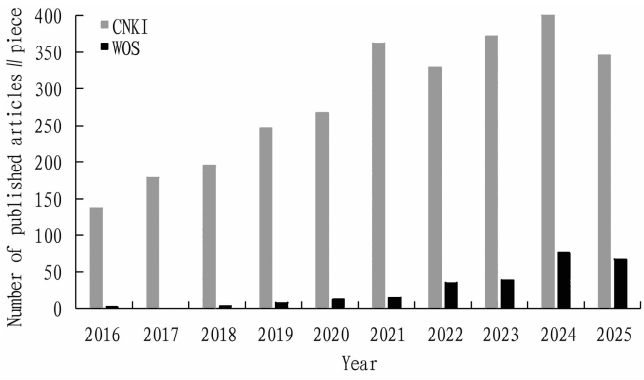

Fig. 1 Distribution of the annual publication volume of CNKI and WOS literature on Huangjing from 2015 to 2025

the total. This finding closely aligns with the extensive historical application of Huangjing in traditional Chinese medicine. The literature predominantly emphasizes core areas including the extraction of medicinal components, optimization of processing techniques, verification of clinical efficacy, and development of compound preparations, thereby reflecting a research focus centered on "the exploration of medicinal value".

Compared to the highly centralized CNKI database, the distribution of research disciplines related to Huangjing in the WOS database is more diversified and interdisciplinary. Its fundamental characteristic lies in being "supported by basic disciplines and diversified through applied disciplines". Agricultural science and technology, as the primary core discipline, along with plant science, forms the "industrial foundation section" of research on Huangjing. The literature predominantly addresses issues of international significance, including the innovation of Huangjing germplasm resources, stress resistance breeding, and ecological planting models, thereby reflecting a research orientation focused on "sustainable resources". Biochemistry, molecular biology, pharmacology, and pharmaceutics constitute the secondary core disciplines in this field. This research has transcended the empirical approach of traditional medicinal plant studies, shifting toward contemporary avenues such as elucidating the molecular mechanisms underlying the efficacy of Huangjing's active compounds, conducting target screenings, and developing novel drug delivery systems. These advancements signify the global academic community's progression toward a phase of "precision and institutionalization" in exploring the medicinal properties of Huangjing.

3.2 Author analysis The co-occurrence map of the author collaboration network illustrates the primary research directions, the contributions of individual authors within the field, and the collaborative relationships among them. As shown in Fig. 3, the size of each node is proportional to the frequency of an author's publications; thus, larger nodes indicate a higher frequency of appearances. The lines connecting the nodes represent co-occurrence relationships, with thicker lines signifying more frequent co-appearances in the same literature and indicating a closer collaborative relationship.

This study utilizes "author" as the central node to conduct

independent analyses of Chinese- and English-language literature. The Chinese-language literature network consists of 279 nodes and 408 connections, while the English-language literature network comprises 272 nodes and 536 connections.

The Chinese author map reveals that research teams publishing in Chinese exhibit multi-clustered structures with robust internal collaboration. A central team, spearheaded by Li Jinling, has dedicated extensive efforts to research on planting and cultivation over an extended period. Additionally, distinct clusters have emerged, led by teams such as those of Liu Yuejun and Wang Biaoteng, each emphasizing unique research areas. The English author map illustrates international participation and cross-regional collaboration. The core teams, led by Gu Wen, are focused on fostering international academic dialogue. The Gu Wen teams conduct in-depth investigations in molecular biology, while the Wang Yue teams focus on clinical applications and their promotion (Table 1).

Close collaboration among various Chinese clusters facilitates resource integration; however, communication between these clusters requires enhancement. The English cluster, spearheaded by China, exemplifies cross-regional cooperation. Internal collaboration bolsters international recognition, whereas interaction across clusters fosters global integration.

Table 1 Top 10 authors ranked by the number of publications

Number	CNKI				WOS			
	Count	Centrality	Year	Author	Count	Centrality	Year	Author
1	22	0.00	2018	Peng Teng	9	0.01	2016	Yu Jie
2	19	0.00	2016	Liu Yuejun	8	0.01	2016	Gu Wen
3	19	0.00	2017	Wang Hualei	6	0.00	2024	Wang Yue
4	18	0.00	2017	Chen Songshu	6	0.00	2024	Cai Wei
5	14	0.00	2018	Jiang Chengxi	5	0.00	2024	Jia Qiaojun
6	14	0.00	2019	Ji Pengzhang	5	0.00	2023	Lao Jia
7	13	0.00	2016	Ma Cunde	4	0.00	2024	Si Jinping
8	13	0.00	2021	Li Jinlin	4	0.00	2021	Zhang Lei
9	12	0.00	2016	Liu Feng	4	0.00	2023	Xie Jing
10	12	0.00	2020	Zhang Lei	4	0.00	2024	Ren Fengxiao

3.3 Institutional analysis The visualization analysis of research institutions' cooperative networks can reveal their collaborative relationships, scientific research capabilities, and influence within a specific field. In the Chinese-language literature, the network consists of 230 nodes and 125 connections, while the English-language literature netwrok comprises 141 nodes and 157 connections (Fig. 4).

Chinese institutions have established a research cluster in the Yunnan region, centered around Yunnan University of Traditional Chinese Medicine, the Institute of Medicinal Plants at the Yunnan Academy of Agricultural Sciences, and Yunnan Agricultural University. This cluster leverages Yunnan's geographical advantages and academic expertise, as it is the primary production area of Huangjing, to advance resource exploration and cultivation. In the Anhui region, research primarily focuses on the medicinal development, chemical composition, and pharmacological mechanisms of Huangjing, with Anhui University of Chinese Medicine, the School of Biology and Pharmaceutical Engineering at West Anhui University, and related research platforms playing a central role. Furthermore, national-level research institutions, such as the Center for Chinese Materia Medica Resources at the China Academy of Chinese Medical Sciences, are actively involved, offering technical expertise and resource support for the research.

Within the institution cooperation network published in English, Yunnan University of Traditional Chinese Medicine, Anhui University of Traditional Chinese Medicine, and China Academy of Chinese Medical Sciences play significant roles, showcasing their prowess in international research output. Similarly, Zhejiang University, Zhejiang A&F University, and the Chinese Academy of Sciences are actively engaged. Moreover, research institutions from countries such as the United States and India, including those associated with Thakur and Kiran, contribute to the global academic network of Huangjing research.

3.4 Research hotspots

3.4.1 Keywords. Keyword emergence refers to a significant increase in the frequency of a certain keyword within a short period, thereby highlighting the research hotspots during that time period and further predicting the research frontiers in that field[5]. In this context, the Chinese-language literature network comprises 282 nodes and 335 connections, while the English-language literature network contains 266 nodes and 544 connections (Figs. 5 – 6).

Keywords such as "chemical components", "Huangjing polysaccharides", and "total flavonoids" form dense clusters, highlighting the extensive research on the active components of Huangjing. Among these, Huangjing polysaccharides are the primary focus of research. A large number of studies have been carried out on their processing, extraction techniques, structural characterization, and pharmacological effects, and the mechanisms of action of polysaccharides in immune regulation, anti-oxidative stress, and other aspects have been clarified. Keywords such as "pharmacological effects", "Alzheimer's disease", "type 2 diabetes", and "anti-tumor" highlight the expanding medicinal value of Huangjing in clinical applications. The research focuses on the potential therapeutic effects of Huangjing and its components in neu-

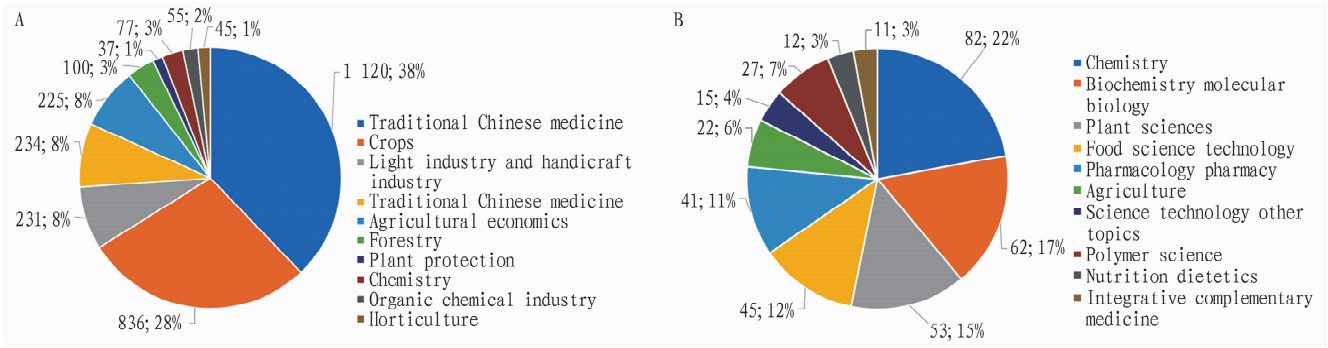

Fig. 2 Disciplinary distribution of Huangjing literature in CNKI (A) and WOS (B)

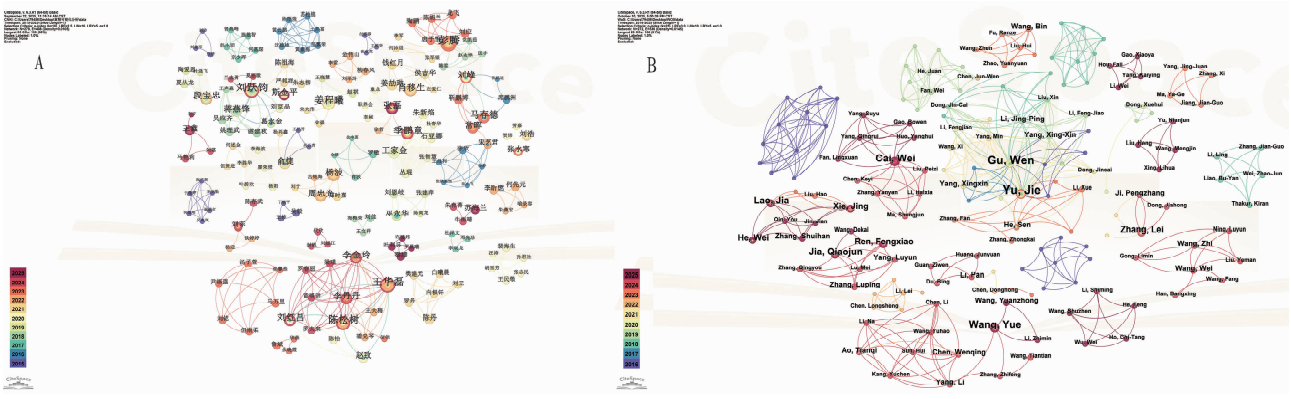

Fig. 3 Collaborative networks of authors in the CNKI (A) and WOS (B) literature on Huangjing

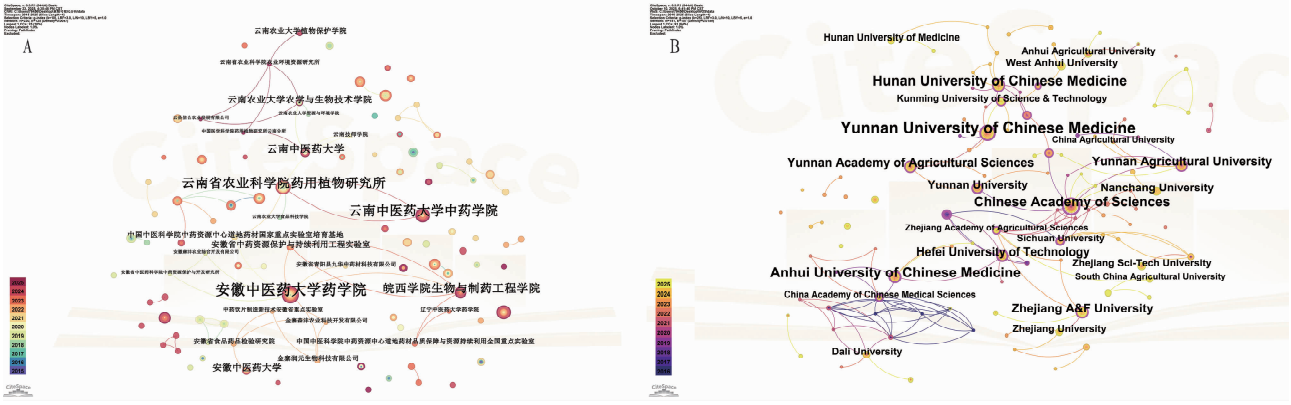

Fig. 4 Cooperative network of research institutions for CNKI (A) and WOS (B) literature on Huangjing

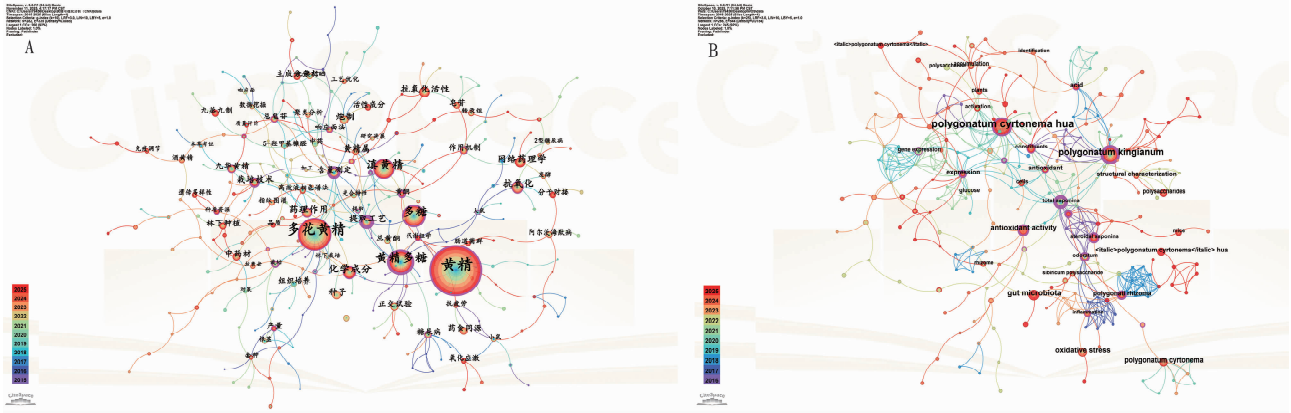

Fig. 5 Co-occurrence network of keywords in the CNKI (A) and WOS (B) literature of Huangjing

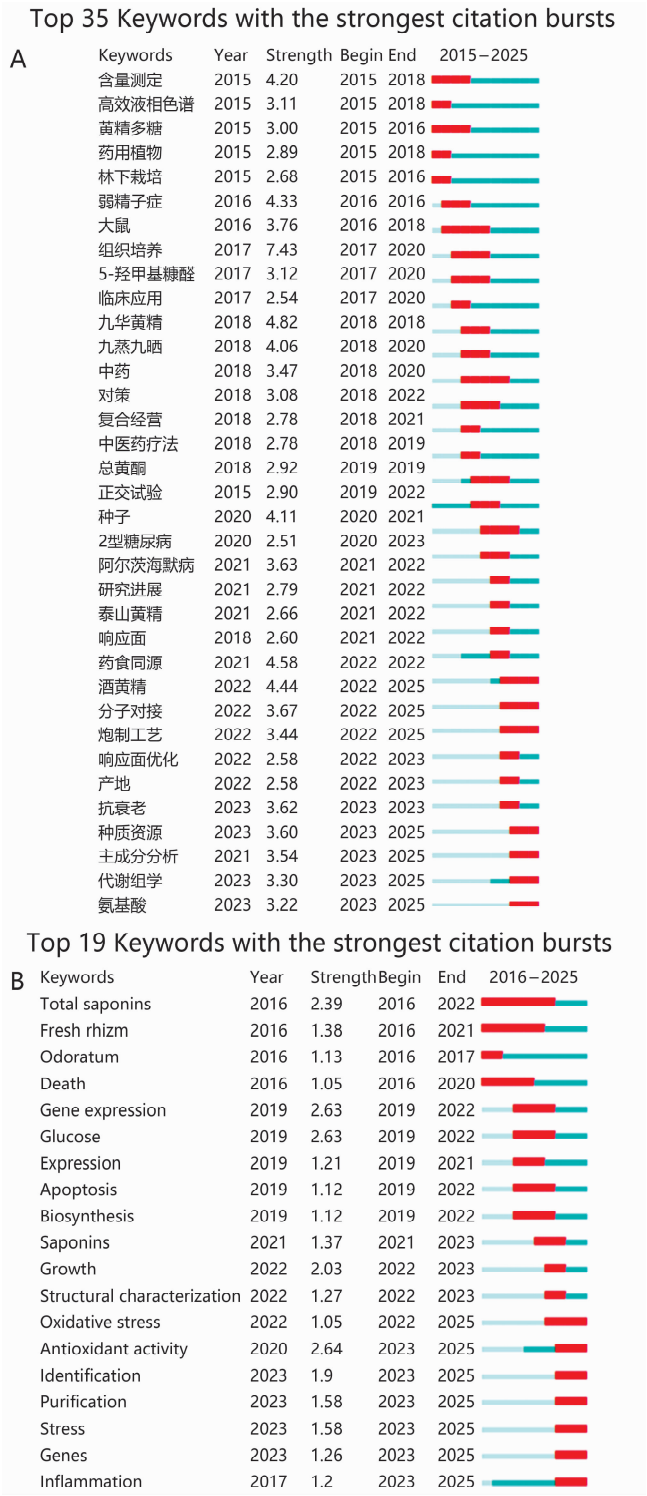

Fig. 6 High-frequency keyword information of the CNKI (A) and WOS (B) literature on Huangjing

rodegenerative diseases, metabolic disorders, tumors, and other related fields. At the same time, it combines traditional Chinese medicine therapy, orthogonal experiments, and other methods to explore application pathways such as compound compatibility and formulation optimization, thereby facilitating the transition of Huangjing from basic research to clinical practice.

The English keyword map highlights Huangjing as the central species, surrounded by various names of Huangjing species, along with terms such as "structural characterization" and "identification". This reflects the global scholarly interest in the precise identification, genetic diversity, and systematic classification of Huangjing, laying the foundation for standardized research on medicinal plants worldwide. Clusters also emerge around keywords such as "gene expression" ,"apoptosis", "biosynthesis", and "gut microbiota", indicating a shift toward investigating the molecular, cellular, and microbial mechanisms of action of the active components in Huangjing. By analyzing the molecular pathways through which Huangjing polysaccharides influence the gut microbiota, this study provides insights into their role in metabolic diseases, offering a theoretical basis for targeted drug development.

Recent research has identified the primary active constituents of Huangjing as polysaccharides (30% – 50%), steroidal saponins (including dioscin and Huangjing saponins A-D), flavonoids (isorhamnetin and apigenin), and 5-hydroxymethylfurfural (5-HMF, a processed product)[6-7]. The structural characteristics of these compounds play a crucial role in determining their biological functions. Notably, Huangjing polysaccharide (PSP) stands out as the key functional component, with its structural properties significantly influencing its bioactivity. Recent studies have revealed that a specific Huangjing polysaccharide, PKP84 (with a molecular weight of 1.7×10^5 Da), exhibits a distinctive triple helix conformation, which confers unique neuroprotective advantages. In experiments involving alcohol-dependent fruit fly models, PKP84 effectively reversed the flies' alcohol preference (preference index, $PI < 0$) and concurrently boosted catalase activity by 49%[8]. This outcome primarily stems from its ability to eliminate oxidative stress byproducts and restore mitochondrial function.

Significant progress has been made in understanding the mechanisms of Huangjing polysaccharides in neuropsychiatric disorders. Research indicates that PSP can ameliorate synaptic dysfunction in depression model mice by targeting the Netrin-1/DCC signaling pathway in the medial prefrontal cortex. This intervention leads to the downregulation of inflammatory factors IL-1β and NF-κB, as well as the glutamate receptor GluN2A/B, while upregulating the postsynaptic dense protein PSD95. Experimental results demonstrate a 35% reduction ($P < 0.05$) in the tail suspension rest time of depressed model mice, underscoring its potential as an antidepressant[9-10]. Furthermore, PSP modulates the gut microbiota-brain axis by increasing the abundance of Bacteroidetes and decreasing the population of thick-walled bacteria in the intestine. This shift promotes the production of short-chain fatty acids, thereby enhancing behavioral outcomes[11]. Additionally, Huangjing polysaccharides influence the intestinal microbiota-bile acid metabolic axis, reducing the cytotoxicity of the secondary bile acid deoxycholic acid (DCA) and alleviating pancreatic β-cell damage induced by cadmium exposure[12-13].

The steroidal saponins in Huangjing, such as dioscin and

Huangjing saponin A, have demonstrated unique value in the treatment of liver fibrosis. Studies have found that such components can activate the p53/Caspase-3 apoptotic pathway, induce apoptosis in activated hepatic stellate cells LX-2, and significantly reduce the expression of α-SMA and Collagen I. *In vitro* experiments showed that the apoptosis rate of hepatic stellate cells could reach 42% ($P<0.01$)[14]. This finding offers a new direction for the treatment of liver fibrosis in the field of anti-tumor treatment; Huangjing saponins also exhibit good activity. Huangjing saponins inhibit the human ovarian cancer cell line A2780 by altering cell morphology, inducing apoptosis, disrupting the cell cycle, and increasing reactive oxygen species. They can also regulate Bcl-2 family proteins and activate the caspase cascade reaction to induce apoptosis. At a concentration of PcHs II −80%, these saponins regulate the expression of related proteins and mRNA, thereby weakening the invasion and metastasis ability of cancer cells[15].

The flavonoid components in Huangjing, such as isorhamnetin and apigenin, participate in mitochondrial energy metabolism by regulating the PGC1α-UCP1 pathway, which can reverse the Warburg effect of tumor cells and reduce the blood glucose and triglyceride levels in mice with glycolipid metabolism disorders, thus playing an important role in the prevention and treatment of metabolic diseases[16].

Meanwhile, research has found that other chemical components in Huangjing also exhibit multiple pharmacological effects. In terms of metabolic regulation, insulin sensitivity can be enhanced through the PI3K/AKT signaling pathway, promoting glucose uptake in IR-HepG2 cells[17]. The compound paste of *P. sibiricum* and lotus leaf can downregulate key genes involved in fatty acid synthesis, such as *SREBP-1c* and *ACC-α*, while upregulating the lipolysis gene *CPT-1*, reducing the accumulation of triglycerides in the liver of rats fed a high-fat diet by 43%[18]. In terms of the mechanism of immunomodulatory action, the polysaccharide PKNH activates Toll-like receptor 4 (TLR4), promoting the proliferation of splenic lymphocytes and the secretion of interferon-γ, increasing the serum IgG1 antibody level in OVA-immunized mice by 2.1-fold ($P<0.01$)[19]. It can also inhibit the progression of lung cancer by downregulating the apelin-PGC1α-UCP1 signaling pathway, inhibiting mitochondrial uncoupling, restoring mitochondrial oxidative phosphorylation, suppressing aerobic glycolysis, and reversing the Warburg effect[20]. The research team led by Khan Haroon *et al.*[21-24] has made good progress in studying the above-ground parts and rhizome components of Huangjing, as well as conducting *in vitro* experiments to investigate its functional components and antibacterial effects (Table 2).

Table 2 Latest research progress on active ingredients and their pharmacological effects

Active component	Core target	Signaling pathway	Pharmacological effect
Polygonatum sibiricum polysaccharide	TLR4/NLRP3	NF-κB inflammatory pathway	Inhibiting enteritis and improving insulin resistance[18-19]
Steroidal saponin	APEX1/STAT3	Cell cycle arrest	Anti-proliferation of lung cancer (inhibition rate > 60%)[20]
Flavonoids	PGC1α-UCP1	Mitochondrial energy metabolism	Reversing Warburg effect and resisting glucose and lipid metabolism disorders[17]

3.4.2 Keyword clustering and timeline clustering analysis. Based on the co-occurrence map of keywords, the log-likelihood ratio (LLR) algorithm was employed to conduct cluster analysis on closely related keywords in the included relevant literature. Analyzing the keyword timeline on the basis of keyword cluster analysis helps to understand the evolution of this field and identify research trends[25]. Using the keyword clustering map, this study conducted a timeline view visualization analysis of keywords from both Chinese- and English-language literature, with the year as the *X*-axis and the clustering label as the *Y*-axis (Figs. 7-8).

Chinese-language research emphasizes the localization chain of "resources-components-efficacy", highlighting the modernization of traditional medicinal knowledge. This approach includes exploring the economic benefits of cultivating medicinal resources in forests and developing innovative compound prescriptions in traditional Chinese medicine. In contrast, English-language research adopts an international approach of "species-molecule-pharmacodynamics", employing established molecular biology and systematic classification techniques to drive innovation in mechanisms and standardize research outcomes.

Timeline clustering enables the analysis of research progress in both Chinese- and English-language articles. The temporal evolution of Chinese-language research can be delineated into three phases. The initial stage (2015-2018) primarily concentrated on fundamental detection techniques, such as content determination and high-performance liquid chromatography, alongside resource investigations involving Huangjing and forest floor cultivation, establishing a methodological and resourceful foundation for subsequent advancements in the field. In the subsequent phase (2019-2021), the focus shifted toward optimizing extraction processes and structurally characterizing Huangjing polysaccharides and total flavonoids, integrating technologies such as network pharmacology and molecular docking to advance component research at the mechanistic level. The final phase (2022-2025) expanded into clinical applications, such as Alzheimer's disease and anti-tumor treatments, amalgamating traditional Chinese medicine practices with compound innovations, facilitating the transition from fundamental research to industrial implementation.

The temporal evolution of English-language research involves three phases. Phase One (2016-2018) established a foundational framework centered on the species identification of *P. cyrtonema* Hua and *P. kingianum* Coll, as well as the component analy-

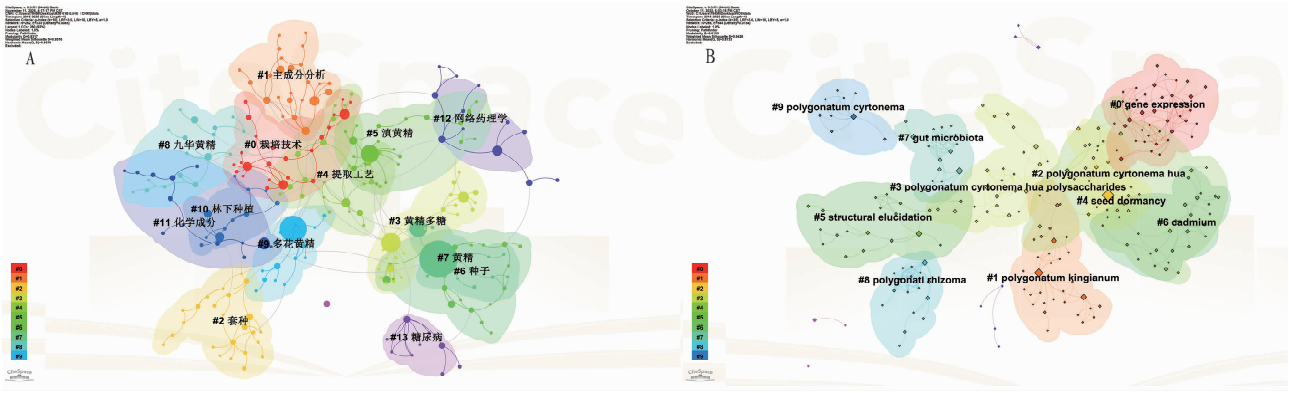

Fig. 7 Keyword clustering networks of CNKI (A) and WOS (B) literature on Huangjing

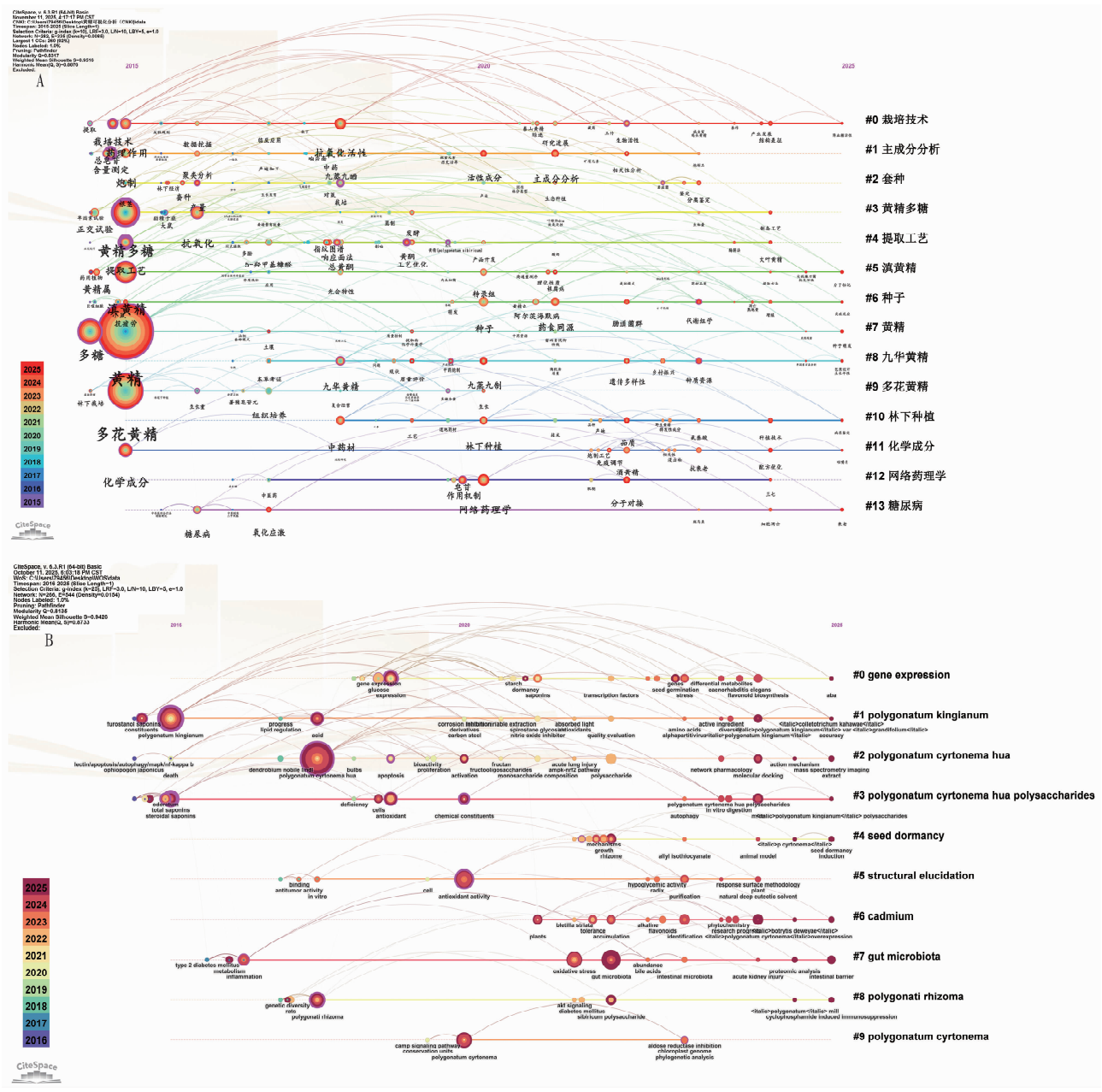

Fig. 8 Timeline clustering networks of the CNKI (A) and WOS (B) literature of Huangjing

sis of total saponins and fresh rhizomes. Phase Two (2019 – 2021) shifted focus to molecular mechanisms, including gene expression, glucose metabolism, and apoptosis, while also exploring the role of gut microbiota to elucidate the target sites of Huangjing's efficacy. Phase Three (2022 – 2025) aimed to expand into areas such as the standardization of identification methods, purification of components, and evaluation of antioxidant activity, thereby facilitating the establishment of international standards and promoting the industrial application of Huangjing research.

The polysaccharides, antioxidants, and anti-aging properties of Huangjing are prominent topics in both Chinese- and English-language literature, each with complementary research orientations. Chinese-language studies primarily concentrate on refining polysaccharide extraction methods and exploring clinical applications, reflecting an "application-driven" approach. In contrast, English-language research places greater emphasis on analyzing the molecular structure of polysaccharides and investigating the regulatory mechanisms of intestinal flora, embodying a "mechanism-driven" perspective.

4 Discussion and prospects

Huangjing, a traditional Chinese medicinal material recognized for its dual role as both food and medicine, boasts a long history and rich cultural significance. Its chemical composition is intricate and varied, encompassing numerous active compounds such as polysaccharides, saponins, and flavonoids. This plant exhibits multiple pharmacological effects, including antioxidative, anti-inflammatory, immunoregulatory, hypoglycemic, and lipid-lowering properties.

The distinctive attributes of Huangjing have led to the emergence of various products in today's market, including health foods, functional foods, beverages, and medicines. These products have been extensively utilized in the domains of medicine and health foods. However, a comparison between local enterprise standards for Huangjing food, as listed on the "Food Partner Network", and the standards in the *Chinese Pharmacopoeia* reveals notable differences. While most localities and enterprises tend to enforce standards stricter than those outlined in the pharmacopoeia, some food enterprises, when developing standards based on resource characteristics, rely solely on sensory attributes such as color and taste. This approach often neglects the critical content of active ingredients, such as polysaccharides and saponins.

The composition and pharmacological properties of the primary constituents in traditional versus modern processing methods of Huangjing can differ significantly. As a result, selecting suitable processing techniques is crucial for maximizing the therapeutic, wellness, or consumption benefits of Huangjing. Nevertheless, existing comparative analyses of pharmacodynamic changes before and after processing, clinical investigations, and the mechanisms associated with chemical constituents remain insufficiently thorough and detailed.

The dual nature of Huangjing as both an edible and medicinal substance is pivotal to its utilization, with processing playing a critical role in unlocking these properties. Processing not only addresses safety concerns associated with consuming raw Huangjing but also enhances its medicinal qualities, rendering it effective in both nutritional and therapeutic applications. The forthcoming research focus in the food industry and academia is anticipated to revolve around exploring the interplay among processing techniques, chemical composition, and pharmacological effects of Huangjing to develop novel decoction pieces suitable for direct consumption.

In view of the progress of the Healthy China Initiative, it is essential to strengthen the standardization of Huangjing processing technology, including establishing a quality control system based on chromatographic fingerprints. Additionaly, the range of food and drug derivatives from common sources should be expanded to enhance synergy across various fields, positioning Huangjing as a model for the modern application of traditional Chinese medicine. Ultimately, I encourage researchers from diverse disciplines, both domestically and internationally, to collaborate in conducting comprehensive and in-depth interdisciplinary studies of Huangjing. Such joint efforts are essential for advancing the high-quality development of the Huangjing industry.

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