



Research article

Research on Chinese medicinal materials cultivation: A bibliometric and visual analysis

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ABSTRACT

Chinese medicinal materials (CMMs) are important strategic resource in China. The cultivation process of medicinal plants is the key link which directly affect the quality and efficacy. The literatures of CMMs cultivation were acquired from China National Knowledge Infrastructure (CNKI) database and State Intellectual Property Office (SIPO) patent database for the years between 2001 and 2021. All the articles found were subjected to bibliometric analysis. The development trends and key topics were analyzed and visualized by VOSviewer and CiteSpace software. The results indicate that ecological planting, under-forest economy, intercropping patterns and industrialization production are the research hotspots in this field; cultivation technology and nutritional fertilization technology are the main areas addressed in recent years. Therefore, the high-quality and sustainable development of CMMs cultivation should be examined in terms of theoretical approaches, technical innovation, multi-cooperation, and intellectual property protection.

1. Introduction

Traditional Chinese medicine (TCM) is a treasure of brilliant Chinese culture. In recent years, TCM is widely used all over the world. TCM has significantly contributed to protecting human health in the fight against COVID-19 [1]. The quality of CMMs directly impacts the safety and clinical efficacy. However, wild herbal resources have been over-exploited for a long time due to the improvement of people's living standard and health consciousness, along with their blind pursuit of "pure natural". The protection of wild medicinal herbs is confronted with rigorous challenges. Certain rare and precious wild herbs are on the edge of extinction [2]. For example, *Gymnadenia conopsea* and *Aster tianmenshanensis* (*Asteraceae*) have a conservation status of endangered and critically endangered,

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respectively [3,4]. Many wild herbal resources are insufficient to fulfill market demand. Therefore, the artificial cultivation of medicinal plants is the most feasible and an inevitable trend [5]. Many countries and regions have formulated a series of relevant guidelines to encourage the further development of CMMs [6], including seed resource protection, seed breeding subsidies, planting base construction, good agriculture practice (GAP) management, harvesting and processing. The planting industry of CMMs has ushered in an unprecedented opportunities, but also facing new challenges. According to incomplete statistics [7], the planting area of CMMs is around 1.37×10^7 acre in 2020, yet 191 kinds of commonly used medicinal herbs accounts for 69.24% (9.51×10^6 acre) of the total area.

The cultivation of medicinal plants has a long history in China. The *Compendium of Materia Medica* (Ben cao gang mu) was written by Li Shizhen, a famous doctor in the Ming dynasty. He pointed out the planting time and precautions of various Chinese herbal medicine. The TCM industry has developed rapidly in recent decades. However, the quality of CMMs has become a bottleneck which hinder its future growth. First of all, the production area and ecological environment of CMMs are critical, which have great influence on the therapeutic efficacy [8]. There is a famous saying in Chinese: “If oranges grow in the south of Huaihe river, they are oranges; but if they grow in the north of Huaihe river, they are trifoliolate oranges”. Ancient observers recognized that different geographical regions can impact medicinal nature. Secondly, the cultivation of CMMs mostly depends on experience, with no professional or methodical guidance. The single planting model, poor management, substandard cultivation and processing techniques, imperfect supporting policies and quality standard system [9], the risk of contaminant (e.g., heavy metals, pesticides residues) [10,11] and the limited scale of GAP bases are the problems to be solved urgently in the growth of CMMs planting industry.

Bibliometric analysis is a mathematical and statistical method to demonstrate the current research situation and development of natural and social sciences, and analyze the literature characteristics (e.g., literature quantity, publication date, authors, institutions, keywords, etc.). It is an important tool for measuring and evaluating the impact in the particular field [12]. It is gradually applied to various fields of TCM in recent years, including journal evaluation, classical inheritance, clinical therapy, and medication mechanism [13]. VOSviewer and CiteSpace are important softwares for constructing visual bibliometric networks [14,15]. Several global bibliometric analysis in TCM therapy have employed Citespace software to cancer [16], insomnia [17], smoking cessation [18], heart failure [19] and chronic pain [20]. The purpose of this study is to make a systematic bibliometric analysis of the literature in the cultivation of CMMs from 2001 to 2021, including the number of publications, authors, institutions, keywords and technology patents. Furthermore, the data mining was applied to investigate the patent technology of CMMs cultivation. Hopefully, this study will help researchers better understand the research status, hot topics and frontier trends in this field.

2. Materials and methods

2.1. Data collection and search strategy

The data was collected from CNKI database and SIPO patent database. The subject terms were as follows: “Chinese medicinal materials” or “Chinese herbal medicine” AND “planting” or “cultivation” or “farming”. The publication time from January 2001 to December 2021. Manually screen the results, then export them into “EndNote” format, and the data were filtered and transformed

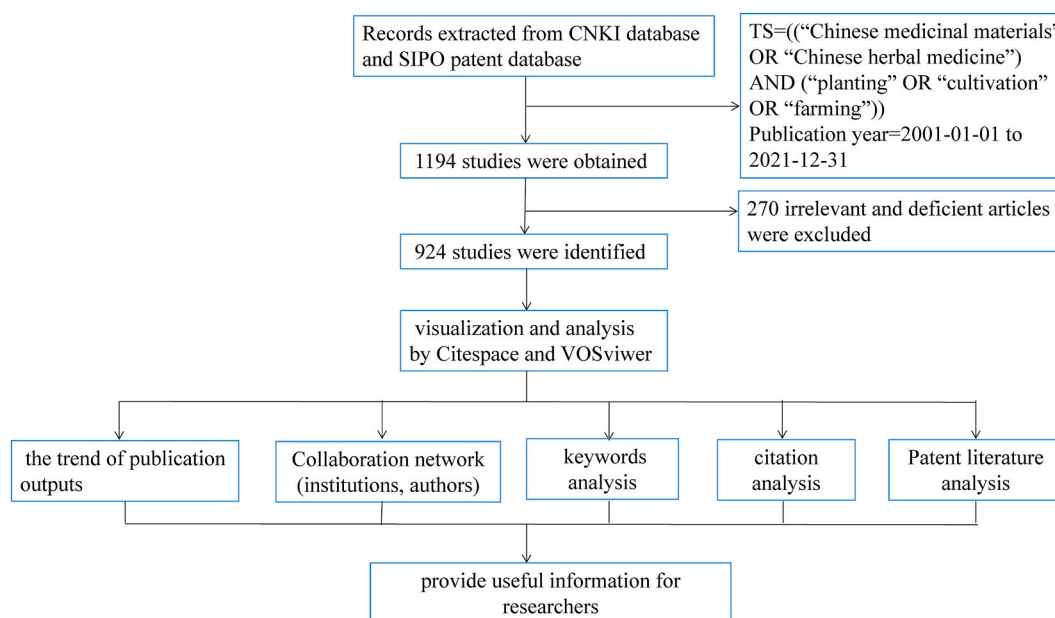


Fig. 1. The overview and flowchart of the study design.

using CiteSpace's "Data" function, so that the data could be recognized by CiteSpace.

2.2. Data analysis

Import the collected data into VOSviewer (version 1.6.14) and CiteSpace software (version 6.1) for data visual analysis. VOSviewer was used to construct the relationship network and visually analysis the number of articles, publication years, literature sources, literature citation frequency, authors, institutions, keywords and other items [21]. The bibliometric graph was displayed by the distance, size and density between nodes. CiteSpace is a scientific software based on co-citation analysis theory and pathfinding network algorithm, which visually reveal the development status, dynamics and frontiers in scientific knowledge [22]. The whole data analysis process is shown in Fig. 1.

3. Results

3.1. Literature distribution characteristics

Initially, a total of 1194 articles on the subject of CMMs cultivation were obtained by searching the CNKI database. After removing the irrelevant and deficient data, 924 studies included eventually. Fig. 2 shows the number trend of annual publications related to the cultivation of CMMs. The first period (2001–2005) with an average of 21 publications per year, showed a fluctuating growth. The second period (2006–2015) had an average of 38 publications per year, and the development was increased slightly. The third period (2016–2021) kept a rapidly growing trend, and the number of annual publications ranged from 55 to 84. A total of 448 papers were published during this period, which account for 49.02% of all the included studies. These results illustrate that this topic has received more attention in the past five years than previously. In terms of the organizations, there were 872 institutes involved in the field of CMMs cultivation. It is worth noting that the domestic research in this field is extensive and universal. The top 3 institutions were the Anguo Chinese Materia Medica Research Association, the China Academy of Chinese Medical Sciences, and the Heilongjiang University of TCM. In addition, the top 10 institutions published 162 articles, which only contribute 17.53% of the total publications (Table 1). As shown in Fig. 3, the cooperation between research institutions need to be strengthened. The 924 papers were published in 421 journals. The 10 most productive journals published 261 papers, accounting for 23.40% of the total number of papers identified. Agricultural journals make up seven of the top 10 journals, while review and practice cases are the majority types of the literature. The journal *Special Economic Animals and Plants* and *Modern Chinese Medicines*, which had the greatest publications, each accounting for 2.92% of all articles. And *Agricultural Development & Equipments* ranked the third with a proportion of 2.81% (Table 2).

3.2. Analysis of authors

Author cooperation networks were mapped using the VOSviewer software. Fig. 4 shows the co-author network, which includes 195 authors and each author with at least 4 articles. There were 33 writers having collaboration links among them. The nodes in the map represent authors, and lines between the nodes represent the collaborative relationships of authors, and the size of nodes represents the quantity of publications [23]. There were formed 4 clusters in all. The cluster in green color was dominated by Guo LP and Huang LQ, who had the highest number of papers. The study areas mainly focus on ecological planting mode and technology of CMMs [24], the cultivation of genuine medicinal materials, poverty alleviation by science and technology [25], bionic cultivation [26], and other related fields. These papers were mostly published in the *China Journal of Chinese Materia Medica*. The cluster in red color was primarily

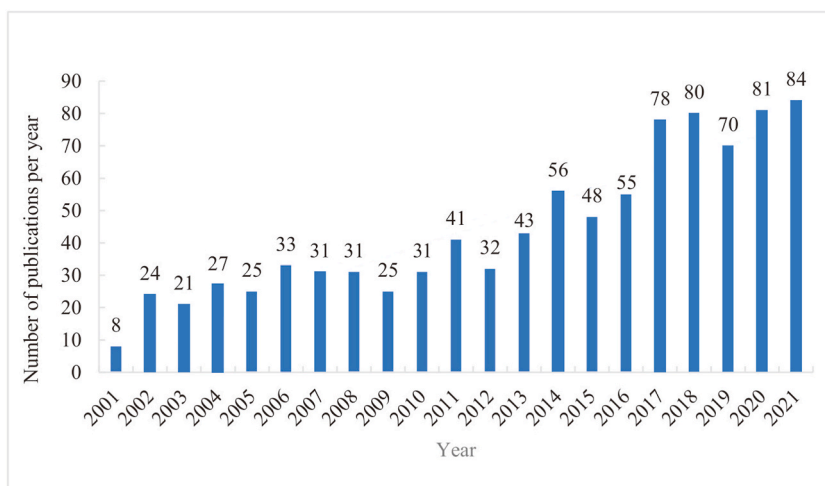


Fig. 2. The annual quantity of publications in the field of CMMs cultivation from 2001 to 2021.

Table 1
Top 10 most productive institutions.

Rank	Institution	Article n (%)
1	Anguo Chinese Materia Medica Research Association, Hebei Province	31 (3.35)
2	China Academy of Chinese Medical Sciences	26 (2.81)
3	Heilongjiang University of Traditional Chinese Medicine	18 (1.95)
4	Institute of Chinese Materia Medica Medicine of China Academy of Chinese Medical Sciences	14 (1.52)
5	Guangxi Medicinal Botanical Garden	14 (1.52)
6	Chongqing Institute of Medicinal Plant Cultivation	13 (1.41)
7	Shandong University of Traditional Chinese Medicine	12 (1.30)
8	Guangxi University	12 (1.30)
9	Anhui University of Traditional Chinese Medicine	11 (1.19)
10	Beijing University of Traditional Chinese Medicine	11 (1.19)

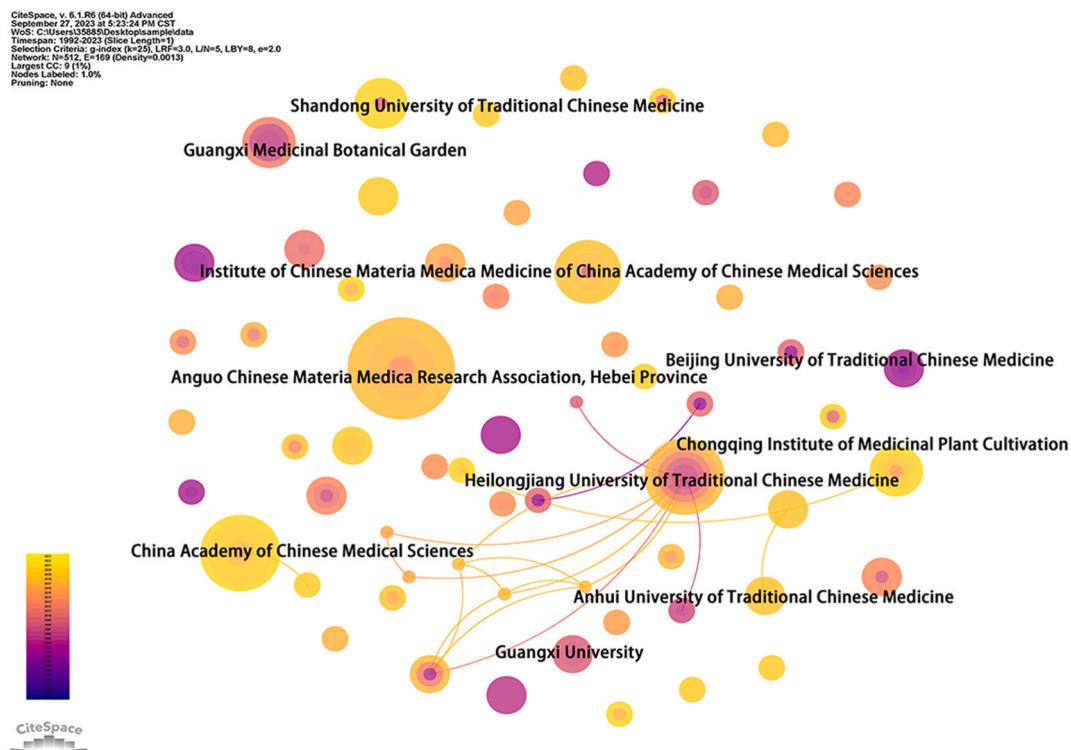


Fig. 3. Collaboration network of institutions.

Table 2
Top 10 most publication journals.

Rank	Journal Name	Article n (%)
1	<i>Special Economic Animals and Plants</i>	27 (2.92)
2	<i>Modern Chinese Medicine</i>	27 (2.92)
3	<i>Agricultural Development & Equipments</i>	26 (2.81)
4	<i>Beijing Agriculture</i>	25 (2.71)
5	<i>Modern Agricultural Science and Technology</i>	20 (2.16)
6	<i>Agriculture and Technology</i>	19 (2.06)
7	<i>Agricultural Science-Technology and Information</i>	19 (2.06)
8	<i>Modern Agriculture</i>	19 (2.06)
9	<i>South China Agriculture</i>	18 (1.95)
10	<i>China Journal of Chinese Materia Medica</i>	16 (1.73)

led by Wang S and Kang CZ, who had the largest number of cooperation partners. The main content include soil fertility [27] and simulated cultivation, as well as regional distribution [28]. The cluster in blue color was mostly led by Meng XC, etc. The research topic include seeds, production [29], yield [30] and the production of high-quality medicinal materials [31]. The cluster in yellow color was

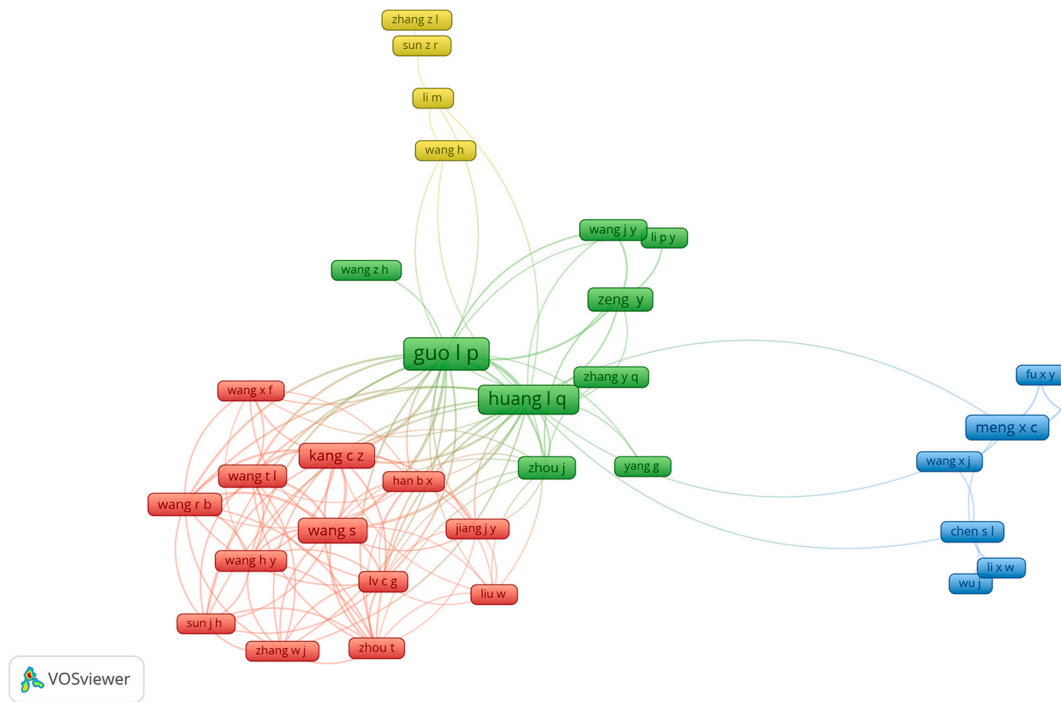


Fig. 4. Collaboration network of authors.

authored by Zhang ZL and other writers. The main research field are as follows: plant growth regulators [32] and growth inhibition measure [33] (Table 3). Through the analysis of authors' organizations, it is found that most authors prefer to cooperate with authors from the same institution.

3.3. Analysis of keywords

The keywords were used to describe the subject and key points of the paper, and the keywords with high frequency can reflect hot research topics. Keyword burst refers to the increasing frequency of keywords within a certain time interval. Through the burst analysis of keywords with CiteSpace, we can visually detect the changes of research hotspots in this field. Fig. 5A shows the beginning and ending timings of the first 3 burstness terms from 2004, as well as the burst intensity and variations over time. There were three burst keywords (i.g., weeding-cultivating, CMMs and countermeasures), which continued to 2017.

A total of 108 keywords were extracted from the 924 articles, and the minimum frequency was set at 4 times. The keyword cluster is

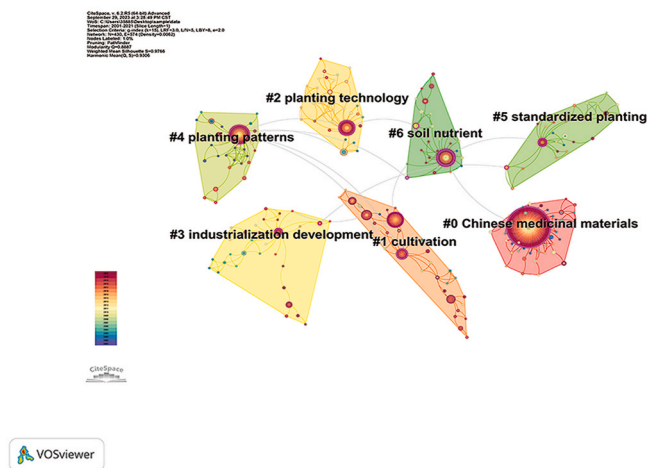
Table 3
The publications number of representative research teams members.

WANG S Team		GUO L P Team		Meng X C Team		ZHANG Z L Team	
Author	Number of publications	Author	Number of publications	Author	Number of publications	Author	Number of publications
WANG S	7	GUO L P	16	MENG X C	6	ZHANG Z L	3
KANG C Z	6	HUANG L Q	12	GUO H M	3	SUN Z R	2
WANG R B	4	ZHOU J	3	CHEN S L	3	LI M	2
WANG T L	4	ZHANG Y Q	3	FU X Y	2	WANG H	2
LIU W	3	ZENG Y	3	WU J	2		
LV C G	3	WANG J Y	3	LI X W	2		
ZHOU T	3	LI P Y	2	WANG X J	2		
WANG H Y	3	YANG G	2	J			
SUN J H	2	WANG Z H	2				
ZHANG W J	2						
JIANG J Y	2						
HAN B X	2						
WAN X F	2						

Top 3 Keywords with the Strongest Citation Bursts

Keywords	Year	Strength	Begin	End	2001-2021
Weeding-Cultivating	2001	3.18	2004	2005	
Chinese Medicinal Materials	2001	4.52	2007	2008	
Countermeasure(s)	2001	3.17	2014	2017	

A



B

Fig. 5. Burst analysis of keywords and clustering network of keywords in the field of CMMs cultivation from 2001 to 2021. (A) Top 3 keywords with the strongest citation bursts. (B) Clustering network of keywords.

generated by CiteSpace. In the cluster analysis, the module value Q and the average clustering contour value S were 0.8887 and 0.9766, respectively, showing good homogeneity. The clustering structure was significant and the clustering result was reliable. The 7 main clusters are shown in Fig. 5B. Cluster #0 and cluster #1 indicated the artificial cultivation of CMMs; Cluster #2 and cluster #4

Table 4

Top 10 articles with the most citations.

Rank	Title	Journal	Author(s)	Citations	Year
1	Research on precise poverty alleviation of characteristic industries in ethnic minority areas: a case study of Chinese medicinal materials industry development	<i>Journal of South-Central University for Nationalities (Humanities and Social Sciences)</i>	MA N	178	2016
2	Survey of investigations on Daodi Chinese medicinal materials in China since 1980s	<i>China Journal of Chinese Materia Medica</i>	XIAO X H et al.	167	2009
3	Good agricultural practice (GAP) of Chinese materia medica (CMM) for ten years: achievements, problems and proposals	<i>China Journal of Chinese Materia Medica</i>	GUO L P et al.	113	2014
4	National wide quality surveillance and snalysis of Chinese material medica and decoction pieces	<i>Chinese Pharmaceutical Journal</i>	WEI F et al.	109	2015
5	Chinese <i>Sanqi</i> industry status and development countermeasures	<i>China Journal of Chinese Materia Medica</i>	CUI X M et al.	102	2014
6	Advances of modern in studies on <i>Codonopsis Pilosula</i>	<i>Journal of Gansu Normal Colleges</i>	ZHANG J J et al.	98	2017
7	Overview on the mechanisms and control methods of sequential cropping obstacle of <i>Panax notoginseng</i> F. H.Chen	<i>Journal of Mountain Agriculture and Biology</i>	LIU L et al.	98	2011
8	“Internet plus traditional Chinese medicine”: reconstructing development pattern of the traditional Chinese medicine’s whole industry chain	<i>China Soft Science</i>	CHEN J F et al.	96	2016
9	Ecological agriculture: future of agriculture for Chinese material medica	<i>China Journal of Chinese Materia Medica</i>	GUO L P et al.	72	2016
10	Research of pollution-free and precision cultivation system of Chinese herbal medicines	<i>China Journal of Chinese Materia Medica</i>	CHENG S L et al.	81	2018

were mainly associated with planting technology and planting patterns of CMMs, including under-forest planting, ecological planting, intercropping, bionic cultivation, etc; Cluster #3 was mainly related to the construction of herbal bases and sustainable development of TCM industry; Cluster #5 focused on the standardized management and planting base of CMMs; Cluster #6 focused on the soil nutrition of CMMs cultivation.

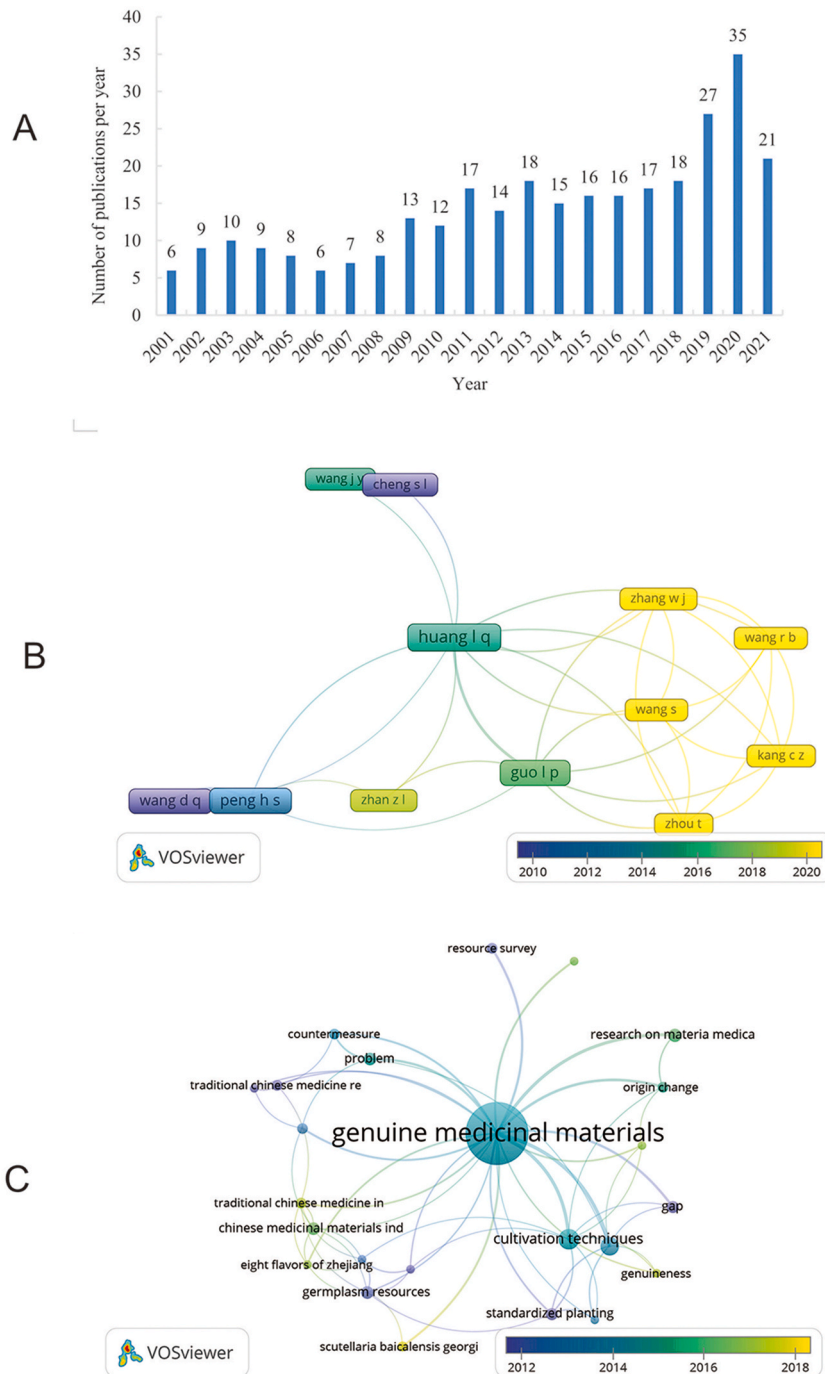


Fig. 6. Annual trends of publications (A), author collaboration network (B) and hotspots map (C) in the field of genuine medicinal material cultivation from 2001 to 2021.

3.4. Most cited articles

The foundational literature and evolutionary routes of the field were revealed by the literature co-cited analysis. The literature with a higher co-citation frequency has a larger impact in the field. Table 4 shows the top 10 most cited articles from the 924 articles. Among them, the high cited articles were published in 2014 and 2016. Five of them were published in the *China Journal of Chinese Materia Medica*, which primarily focused on the growth of TCM industry, standardized production, and practical examples of genuine medicinal materials cultivation. The article entitled “Research on precise poverty alleviation of characteristic industries in ethnic minority areas: a case study of Chinese medicinal materials industry development” had the most citations. This article was manifested in three aspects, including innovation industry development mode, follow the principle of “according to local conditions”, and set up a early warning mechanism of industry classification, which provide references for poverty alleviation in the new era.

3.5. Genuine medicinal materials

The genuine medicinal materials, also known as Dao-di herbs, are recognized as high-quality medicinal products of CMMs [34]. They have the characteristics of excellent quality, good efficacy, stable quality and high-profile compared to non-authentic herbs [35]. A total of 302 articles related to genuine medicinal materials cultivation were involved. In general, the annual quantity of research publications on the cultivation of genuine medicinal materials was few. From 2001 to 2008, the number of publications per year was less than 10. However, there were more than 10 papers per year during 2009–2021, with a maximum of 35 articles in 2020 (Fig. 6A). A total of 35 authors were included in the network, and each writer had at least 3 papers. There were 12 authors with collaborative relationships (Fig. 6B). The nodes in the figure represent authors, lines represent collaborative relationships between authors, node size represents the number of publications, and colors from dark to light indicate the time is drawing near. Huang LQ and Guo LP teams were the most active participants, who contributed the largest number of papers in this research field and showed stronger collaboration with other authors. As shown in Fig. 6C, the research hotspots of this field in the past three years have concentrated on ecological agriculture, ecological planting, seed resource conservation, herbal textual and industrialization of CMMs. The study topics closely match the national strategy of TCM development and the rural revitalization strategy, which provide an important decision-support for the strategic planning of TCM industry.

3.6. Patent literature analysis

Patent literature, as an important carrier of technological innovation, implies extremely economic and technological value. It is the data source of technology mining in industry/technology field. Patent analysis can reflect the hotspots and trends in the related fields. According to patent type presented in Fig. 7A: during 2001–2021, the number of invention patents constituted for 80.49% of all the patents. Of these, 455 were authorized patent, accounting for 15.45% of the total number of invention patents. Fig. 7B shows the application trend of invention patents, the development of CMMs cultivation technology has experienced three periods: a steady growth period (2001–2009), a rapid growth period (2010–2017), and a rapid decline period (2018–2021). The reason may be that the planting technology of CMMs has encountered a bottleneck. Therefore, it requires breakthrough innovation and policy regulation from national and local governments to improve the development of this field. As shown in Fig. 7C, the hotspots were mostly distributed in five categories, including soil moisture, pesticides, nutrients, microorganisms, and water content. The technological composition of international patent classification (IPC) reveals that the A01G1/00 (horticulture; cultivation) and C05G3/00 (a mixture of one or more fertilizers with no special fertilizer components), accounting for 27.31% and 14.61% of the total patents, respectively (Table 5). The technical connotation of these two patents is related to cultivation technology. It is clear that cultivation technology and nutrient fertilization are the primary research interests in recent years.

4. Discussion and suggestion

Chinese herbal medicine is a major strategic resource for the poor rural population to poverty alleviation. The cultivation and management of CMMs are a crucial link in the production of Chinese herbs. The wild resources of Chinese herbal medicine are becoming gradually exhausted, due to the population explosion and the intensifying conflict between supply and demand. As a result, the cultivation and industrialized planting of CMMs (especially genuine medicinal materials) have become the effective way to deal with this urgent problem. Based on this, it has been suggested future research of CMMs cultivation should focus on the following four aspects.

- (1) *Emphasize the innovation of research methods and form a theoretical system* The genuine medicinal materials is a comprehensive standard for evaluating the quality of CMMs, which has been established in clinical practice over thousands of years. The current study on the cultivation of genuine medicinal materials is primarily emphasize on practice, and there is no comprehensive theoretical system in this field [36]. Therefore, we should attempt to introduce advanced theories and cultivation techniques of modern agriculture follow the guidance of TCM theories, through the theoretical approaches of standard system, seeds breeding, origin traceability system, and orderly development, strengthen the research on the correlation between genuine medicinal materials and environmental factors, and actively innovate planting technology models and methods [37]. Meanwhile, we should protect the quality of the original resources, actively innovate planting technology models, and cultivate more new varieties of CMMs, establish unique characteristic TCM brands and achieve the sustainable development of TCM. For

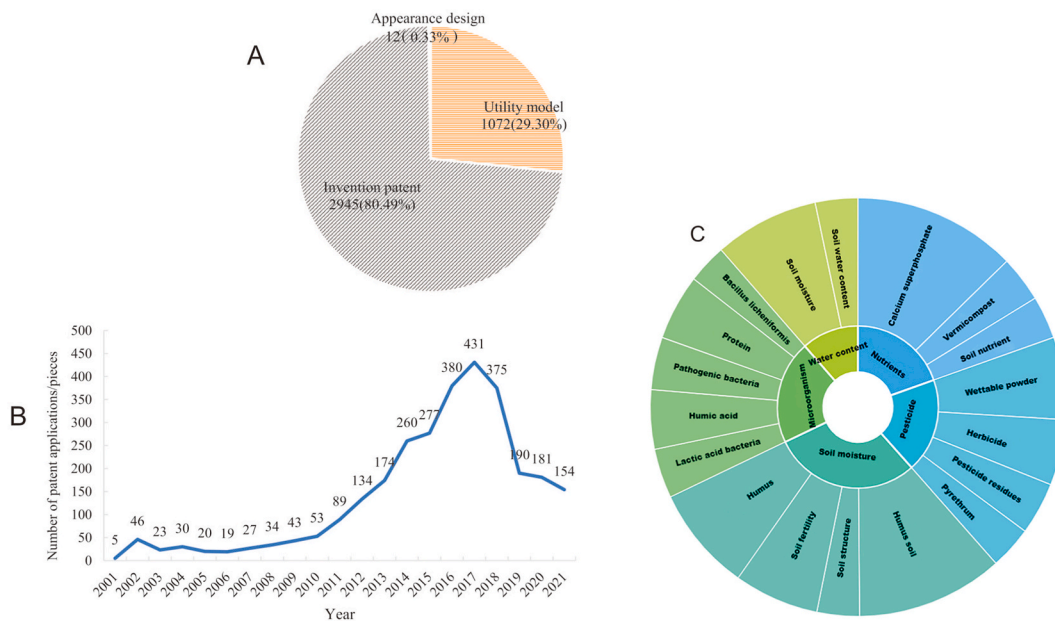


Fig. 7. Patent applications on CMMs cultivation technology. (A) Patent type chart. (B) Patent application trend chart. (C) Hot technology topic sunburst chart.

Table 5

Top 10 IPC technological composition of CMMs cultivation technology.

Rank	IPC	Classification Notes	Number of patents	Percentage (%)
1	A01G1/00	Horticulture; Cultivation	712	27.31
2	C05G3/00	A mixtures of one or more fertilizers with no specific fertilizer components	381	14.61
3	A01C1/00	Apparatus or method for testing or treating seeds, rhizomes, etc. prior to sowing or planting	231	8.86
4	A01C21/00	Fertilizing methods (fertilizer into C05; soil conditioning and soil stabilization materials into C09K17/00)	213	8.17
5	A01G13/00	Plant protection	201	7.71
6	A01G22/25	Root crops, such as potatoes, yams, sugar beets, or wasabi	197	7.56
7	A01G22/00	Cultivation of special crops or plants not mentioned	178	6.83
8	A01G17/00	Cultivation of hops, grapes, fruit trees or similar trees	166	6.37
9	A01P3/00	Bactericide	165	6.33
10	C05G1/00	Mixtures of fertilizers belonging to the sub-categories of C05	163	6.25

example, Zhejiang Province has focused on eight representative genuine medicinal materials and reformulated new strategy for TCM industry development [38].

- (2) *Strengthen the research and popularization of ecological planting technology of CMMs* The ecological planting of CMMs is a cultivation technology that aims to coordinate both ecological and economic benefits, and is guided by scientific and modern planting technology to achieve high quality, high yield and high efficient of CMMs and sustainable and healthy development of the environment [39]. The growth and quality of medicinal plants are affected by living environment, including geography, climate, soil, and biological factors. Therefore, we should identify the suitable areas for ecological planting of CMMs according to the natural climate and ecological environment. The ecological planting and management model of CMMs around five categories: soil moisture, pesticides, nutrients, microorganism and water content. Clarify the suitable model for ecological planting of CMMs, explore the change rules of various models in different regions, and formulate technical standards to create an industrial production [40]. Build efficient green herbal demonstration bases and large-scale planting bases of CMMs, which are relying on the technical support of scientific research institutions, and introduce advanced infrastructure from both home and abroad. During the growth of CMMs, it is need to protect against pests and disease in time. In addition, strengthen the supervision and management of national pharmaceutical departments to improve the quality of CMMs. Furthermore, strengthen publicity and education, spread the concept and connotation of ecological planting [41].

- (3) *Enhance diversified cooperation and form multidimensional research synergy* The cultivation research of CMMs has become an important subject to be carried out widely. It has accumulated a profound research foundation thanks to its abundance of research topics, research tools, and research contents. However, through the analysis of keyword burst and keyword clustering network, the research on this study is conventional and lack of innovative. Especially, there are few studies on planting technology innovation and mechanized production, which need to be continuously reinforced. Firstly, it is recommended that academic cooperation among universities, research institutions, agricultural base and pharmaceutical companies should be strengthened to communicate information regarding CMMs, focus on the research of key common technologies, and build an innovation system of production + learning + research + application [42]. Secondly, make good use of scientists and leader's academic and technical resource advantage and establish a "scientist workstation", which are helpful for growers to improve their technical level. In addition, establish Chinese herbal medicine industry association, conduct GAP training courses regularly for hotspots and key issues [6,43], pay a study visit abroad periodically to learn advanced planting and production technologies, and improve the planting of CMMs more scientific and standardized.
- (4) *Strengthen the protection of intellectual property and promote the transformation of scientific and technological achievements* The cultivation technology and nutrient fertilization of CMMs are the focus of patent research, and also the primary factors affecting the yield of CMMs. The correlation analysis of patented technology has shown multiple technologies employed jointly to accelerate the quality and quantity of CMMs. We should explore further into this technology and encourage the transformation of achievements [44]. First of all, it is crucial to strengthen the reform and innovation of planting technology, actively promote the application and transformation of patents related to integrated technology of multiple planting methods [45], to meet the demand of CMMs production. Secondly, the patent application of CMMs cultivation technology gradually enters the declining period at present. We should encourage enterprises to participate in the formulation of quality standards for CMMs, reinforce the peripheral patent layout, and establish a more comprehensive and effective patent protection system of CMMs [46].

5. Conclusion

This bibliometric analysis was performed on the research of CMMs cultivation using the visualization tools. The quantity of CMMs cultivation-related publications has shown an upward trend over the past two decades, which indicates that this field has attracted more and more attention. However, the cooperative interaction between institutions and authors were relatively weak. Guo LP and Huang LQ made important contributions in the field of CMMs and genuine medicinal materials cultivation. Ecological planting, under-forest economy, intercropping patterns, and industrialization production are research hotspots in this area, follow the guidance of national development strategy of TCM industry. Furthermore, CMMs cultivation technology and nutrient fertilization are current research directions, and they are also the bottleneck that need to be solved urgently for the high-quality development of TCM. This findings may help international scholars understand the status, hot topics and development trends in this field.

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Data availability statement

Data included in article/supp. material/referenced in article. Further data will be made available on request.

CRediT authorship contribution statement

Ping Miao: Writing – original draft, Investigation. **Yaoxuan Li:** Investigation, Formal analysis. **Qingtao Fan:** Methodology. **Lulu Ni:** Methodology. **Siqi Liu:** Methodology. **Jiangan Li:** Conceptualization. **Sujuan Zhang:** Writing – review & editing, Conceptualization.

Declaration of competing interest

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

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