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Chinese Medicine and Culture

中医药文化（英文版）

Special Issue: Traditional Chinese Medicine on the Silk Road

Guest Editor-in-Chief:

Ehsan Doostmohammadi (艾森)

Ehsan Doostmohammadi, Iranian, is a research fellow at Center for Iranian Studies at Southwest University, and a recipient of the 16th Special Book Award of China. He serves as an overseas expert at Translators Association of China, a council member and committee member of Translation and International Communication Committee of Chinese Association for Research and Advancement of Chinese Medicine, a member of Traditional Chinese Medicine Committee of World Sinologist Council, and vice president of Hui Medicine (回医药) Committee of World Federation of Chinese Medicine Societies. He has translated many Chinese literary classics into Iranian, including *Bin Hu Mai Xue* [《濒湖脉学》 (*Li*) *Binhu's Teachings on Pulse Diagnosis*], *She Zhen* (《舌诊》 *Tongue Diagnosis in Traditional Chinese Medicine*), *Zhong Yao Xue* (《中药学》 *Chinese Materia Medica*), *Zhong Yi Nei Ke Xue* (《中医内科学》*Traditional Chinese Medicine Internal Medicine*), *Da Xue* (《大学》 *The Great Learning*), *Zhong Yong* (《中庸》 *The Doctrine of the Mean*), *Si Shu Wu Jing De Ming Yan* (《四书五经的名言》 *Famous Sayings from the Four Books and Five Classics*) , etc.

Special Academic Editor:

YANG Yu (杨渝)

Yang Yu is an associate professor at the Foreign Languages Teaching Center of Shanghai University of Traditional Chinese Medicine. She holds a BA and an MA in English Language and Literature, complemented by a Ph.D. in Traditional Chinese Medicine (TCM). Her research spans TCM translation studies, the international standardization of TCM terminology, and TCM history. Her professional roles include serving as an expert member of the Translators Association of China, a review expert for the China Academic Degrees and Graduate Education Development Center (CDGDC), a senior English reviewer for the National Medical Products Administration (NMPA), an accredited expert of the China Academy of Translation, and an executive council member of six national academic societies. She also contributes as a peer reviewer and editorial board member for several core journals indexed in SSCI, CSSCI, and ESCI. Recognized as a Highly Cited Scholar by the China National Knowledge Infrastructure (CNKI), she has authored over 30 papers in CSSCI-indexed and other journals, in addition to 5 textbooks, 11 translated works, and 1 monograph.

Purpose of the Issue

The Silk Road, an ancient network of trade routes connecting the East and West, was not only a conduit for goods but also a channel for the exchange of knowledge, culture, and medicine. TCM was one of the significant cultural and scientific contributions that traveled along these routes, influencing and being influenced by various medical practices across regions. This special issue aims to explore the multifaceted impact of TCM along the Silk Road, highlighting its historical significance, cross-cultural interactions, and lasting legacy. By studying these interactions, we are expected to gain deeper insights into the historical development of TCM and its contribution to global medical practices.

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General Information

AIMS AND SCOPE

Chinese Medicine and Culture is an interdisciplinary academic journal focusing on the study of Chinese medicine. It aims to promote communication and dialogue between researchers in the natural sciences and humanities of Chinese medicine. The objectives are to build an interactive platform for interdisciplinary research on Chinese medicine and to comprehensively reflect the high-level and latest research results of Chinese medicine in the fields of medical science research, cultural exchange and historical heritage conservation.

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Contents

Editorial

CHINESE 中医药文化(英文版)
MEDICINE AND CULTURE

OPEN

Traditional Chinese Medicine on the Silk Road

Ehsan Doostmohammadi[1,✉]

The Silk Road was never a single line on a map but a network of overland routes and maritime paths through which remedies, recipes, and practitioners constantly moved. Together, the 11 articles in this special issue, "Traditional Chinese Medicine on the Silk Road", demonstrate that traditional Chinese medicine (TCM) abroad was not just exported; it was adapted, debated, standardized, and sometimes transformed through contact with Middle Eastern, Southeast Asian, and African medical traditions. Our contributors trace specific actors and substances, link archives to experiments, and highlight the institutional and cultural factors that enable or hinder therapeutic practices.

We start at a late-Qing maritime crossroads. One study revisits *Bin Lang Yu Zhi Lue* (《槟榔屿志略》 *The Monograph on Penang*), written by the imperial physician Li Jun (力钧), to examine how TCM was practiced in Singapore and Penang in the 1890s. Amidst labor migration and colonial regulations, Li's pages capture both diaspora resourcefulness and elite critique, reminding us that overseas TCM was negotiated within new ecological contexts, patient communities, and markets—long before the language of globalization.

From ports to plant routes, a second contribution uses *Rou Gui* (肉桂 Cortex Cinnamomi), etc., to reconstruct a trans-Eurasian commodity history. By mapping names, sources, and uses across South/Southeast Asia, Persian-Arab trade networks, and Western pharmacology, the article demonstrates how ritual, culinary, and medical values stabilized long-distance demand while generating divergent clinical logics. The method—beginning with a single aromatic and integrating braid philology with historical geography and material culture—offers a template for exploring other materia medica across archives and ecosystems.

Two panoramic essays then widen the scope across Eurasia. A survey of ancient China–Middle East exchanges traces translation networks, dosage-form borrowings, and shared technical vocabularies, while a companion history of Sino-Iranian medicine from the classical Silk Roads to modern times shows how texts, physicians, and pharmacological trade produced durable corridors of knowledge. Both pieces move beyond influence-hunting to model co-production: Chinese *Ben Cao* (本草 materia medica) traditions and Persianate/Arabic compendia meeting on recognizably empirical ground. A study of Sino–Vietnamese exchanges introduces a new dynamic—proximity and long textual memory—resulting in a medical system genealogically linked to, yet distinct from, TCM.

Texts come alive through recipes and diagrams. Our review of Dunhuang (敦煌) medical prescriptions explores over a thousand years of therapeutic imagination, evaluates modern experimental progress, and suggests a three-prong approach for responsible change: maintaining diagnostic logics, investing in mechanisms and quality control, and building institutional links for clinical application. Suppose manuscripts keep us connected to historical practice. In that case, laboratory instruments remind us that pharmacology is also material science: a study of herb-infused, naturally fermented rice wines—especially Monascus purpureus red wines—uses FIA and FTIR analyses to show improved antioxidant profiles and potential benefits for delivering herbal bioactives. More than just its specific findings, the paper shows how archives and assays can effectively inform each other.

Institutions and acceptance are as important as decoctions and dosage. A historical and policy analysis of TCM in Indonesia traces early migrant practitioners, the development of training pathways, and the evolution of regulatory frameworks, culminating in current collaboration under the "Health Silk Road". A complementary, data-driven survey of Malay communities in Shah Alam, Malaysia, highlights a common paradox: limited knowledge alongside cautiously optimistic attitudes and a willingness to try TCM. Here, halal certification appears as a key prerequisite for acceptance, while financial status influences both attitudes and behaviors. The clear implication is that regulatory and religious infrastructures are

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not secondary to efficacy. They are integral parts of the therapeutic process.

Expanding the map to Africa, an overview of TCM in Uganda places acupuncture, *Tui Na* (推拿), and artemisinin within the long history of Sino–African cooperation and community-level adoption. A final essay connects African and Chinese traditions through Morocco's endemic Tetraena gaetula, highlighting opportunities (biocultural synergies, diverse treatment options) alongside ethical imperatives (sustainable sourcing, strong standards of evidence, and fair benefit-sharing).

Across these cases, three cross-cutting lessons emerge.

First, mobility is a method. Following specific substances (cinnamon, Tetraena gaetula) and named actors (Li Jun, migrant clinicians) grounds major narratives in verifiable traces—textual, material, and institutional. This approach challenges civilizational essentialism and replaces it with manageable histories of supply chains, substitutions, and clinical reasoning.

Second, evidence is plural and can be compared across different fields. The range of issues extends confidently from codicology and philology (Dunhuang, Sino-Iranian, and Sino-Vietnamese corpora) to chemical analysis (FIA, FTIR) and survey techniques (the Shah Alam study). When combined with transparent protocols—such as stable identifiers for manuscripts, bilingual term lists, validated instruments, and preregistered procedures—plural methods produce results that are meaningful locally and comparable globally.

Third, policy and culture act as pharmacological forces through multiple channels. Halal pathways for herbal products, professional education standards, mutual recognition agreements, and public–private partnerships determine whether proven remedies reach patients safely and fairly. Designing for reception—labels, quality seals, and communication across languages—should be seen as part of translation, not an afterthought.

The goal of this special issue is not to celebrate tradition for its own sake or to reduce diverse practices to a single standard. Instead, it aims to demonstrate, with historical context and methodological humility, how TCM moves, evolves, and demonstrates its efficacy in new environments—from a Penang dispensary ledger and a Dunhuang recipe page to a rice-wine chromatogram, a Malaysian survey table, and a Ugandan clinic logbook. We thank our authors, reviewers, librarians, conservators, community clinicians, and laboratory teams, whose often invisible work supports each contribution. May the conversations sparked here—between archives and assays, ministries and marketplaces—continue to make the Silk Road's medical traffic not only clearer but more equitable.

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Ethical approval

This study does not contain any studies with human or animal subjects performed by the author.

Author contributions

Ehsan Doostmohammadi drafted and revised the manuscript.

Conflicts of interest

Ehsan Doostmohammadi is the Guest Editor-in-Chief of this special issue and a Youth Editorial Board member of *Chinese Medicine and Culture*. The article was subject to the journal's standard procedures, with peer review handled independently of the Guest Editor-in-Chief and Youth Editorial Board member, and his research groups.

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Feature Article

CHINESE MEDICINE AND CULTURE 中医药文化(英文版)

OPEN

Qing Imperial Physician Li Jun's Lens: Chinese Medicine in Late 19th-century Penang

SU Qiuyang[1,✉], Danny Tze-ken Wong[1], Tan Miau Ing[1]

Abstract

Amidst the late 19th-century influx of Chinese laborers into the Straits Settlements, few scholar-physicians engaged in transnational medical discourse, making Qing Imperial physician Li Jun (力钧) a remarkable exception. A distinguished Confucian physician, Li Jun traveled to Singapore and Penang in the 1890s, meticulously documenting his unique observations in his book, *Bin Lang Yu Zhi Lue* (《槟榔屿志略》 *The Monograph on Penang*). This paper explores Li Jun's narratives and critiques of Chinese medicine in Penang, analyzing them through the lens of his elite background and the socio-historical context of the time. By contextualizing his account within the era's healthcare landscape, migration patterns, and colonial dynamics, the paper assesses his views on the role, practitioners, perceived strengths, and limitations of Chinese medicine as practiced overseas. Li Jun's insightful perspective reveals complexities in the adaptation and provision of Chinese healthcare within the diaspora, highlighting its historical challenges and illuminating the interplay between medical traditions and the colonial environment at the time.

Keywords: Li Jun (力钧); Chinese medicine; Penang Island; British Malaya

1 Introduction

In the late nineteenth century, the Straits Settlements saw a substantial influx of Chinese laborers, which played a crucial role in the formation and development of British Malaya. Conversely, during this period, only a small number of Chinese travelers, particularly scholars of traditional Chinese medicine (TCM), chose to venture abroad. However, a notable exception was Li Jun (力钧, 1856–1925), a distinguished Qing imperial physician known known as a Confucian physician (Note 1). His journeys and contributions during this era were particularly remarkable.

Li Jun's exceptional medical writings and valuable archives are preserved by the Library of the Chinese Academy of Medical Sciences. Building on this legacy, Chen Keji (陈可冀) edited and published *Qing Dai Yu Yi Li Jun Wen Ji* (《清代御医力钧文集》 *Collected Works of Li Jun, an Imperial Physician in the Qing Dynasty*) in 2013.[1] Subsequently, Wang Zongxin (王宗欣) compiled a comprehensive twelve-volume collection, *Li Jun Wen Xian Quan Bian* (《力钧文献全编》 *The Complete Collection of Li Jun*).[2] Additionally, *Bin Lang Yu Zhi Lue Jiao Zhu* (《槟榔屿志略校注》 *The Annotated Edition of the Monograph on Penang*), edited by Nie Dening (聂德宁) and Yon Wen Woe (阮湧俐), and published by Xiamen University Press in 2022, has further enriched scholarly engagement with Li Jun's contributions.[3] Despite increasing scholarly interest in Li Jun's significant contributions to medical literature and academic discourse, his works remain largely unexamined within Western academia. Of particular note, in 2024, French sinologist Claudine Salmon offered a brief introduction to *Bin Lang Yu Zhi Lue Jiao Zhu* in *Archipel*, which to date has stood as the sole overview of the text available in English.[4]

This paper explores Li Jun's narratives and critiques of Chinese medicine in Penang in *Bin Lang Yu Zhi Lue* (《槟榔屿志略》 *The Monograph on Penang*), analyzing them through the lens of his elite background and the socio-historical context of the time (Note 2). By contextualizing his account within the healthcare landscape, migration patterns, and colonial dynamics of the era, it assesses his views on the role, practitioners, perceived strengths, and limitations of Chinese medicine practiced overseas. Li Jun's insightful perspective reveals complexities in the adaptation and provision of Chinese healthcare within the diaspora, highlighting contemporary challenges and illuminating the interplay between medical traditions and the colonial environment.

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2 Li Jun's (力钧) journey to British Malaya

2.1 Chinese physician encountering Western medicine

Li Jun, known by his courtesy name Xuanju (轩举) and pseudonym Yiyin (医隐), was born in Yongtai, Fuzhou, in the Fujian province (福建省) of China. He came from a distinguished literati family in Fuzhou. His father, Li Quguan (力渠官), his uncle, Li Qiuguan (力秋官), his younger brother, Li Qiang (力锵), and Li Jun himself all successfully passed the provincial imperial examination.[5]

Beginning at age six, Li Jun received rigorous training in TCM and classical scholarship from esteemed Confucian physicians. In 1877, he founded his medical practice, where he both treated patients and educated the public about medical knowledge, earning a strong reputation for his exceptional skills. After 1881, he collaborated with renowned TCM masters to co-author several works, and he leveraged his extensive clinical experience and insights.[6]

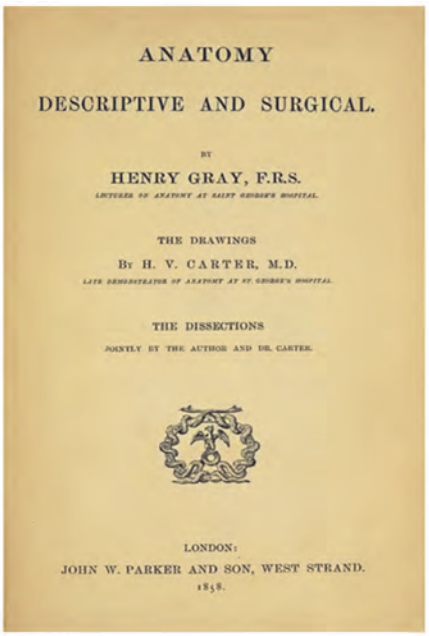
Since the early 19th century, Western medicine has been introduced into China by medical missionaries, with Fuzhou (福州) being one of the five treaty ports open to foreign trade and medical missions. In 1870, Dr. Dauphin Osgood (柯为良), a medical missionary with the American Board, arrived in Fuzhou and established the Foochow Medical Missionary Hospital (福州圣教医院). Over the years, the hospital treated over 51,838 patients, including approximately 1,500 for opium addiction.[7] On August 16th, 1880, a day before his death, Dr. Osgood completed a five-volume Chinese translation of *Gray's Anatomy*, titled *Quan Ti Chan Wei* (《全体阐微》 *Anatomy, Descriptive and Surgical*) (Fig. 1).[8]

Li Jun demonstrated a keen interest in Western medicine and led efforts to integrate it with Chinese medicine in the 1880s. During his travels to Shanghai and Tianjin, he acquired an extensive collection of traditional Chinese and Western medical books, notably delving deeply into *Xi Yao Lue Shi* (《西药略释》 *Brief Explanations of Western Medicine*) and meticulously comparing Western medicine with Chinese herbal remedies. These interactions broadened his perspective, inspiring him to explore medical practices internationally.

2.2 Visits to Nanyang in the 1890s

Fuzhou's long history of migration has significantly influenced its diasporic traditions, as generations of Fuzhounese sought opportunities and safety abroad. The city has maintained strong connections with Southeast Asia, particularly with many immigrants relocating to British Malaya and Java in the late 19th century. Wong Nai Siong (黄乃裳, 1849–1924), a prominent Chinese revolutionary leader and pioneer, spearheaded efforts to establish a "New Fuzhou" in Sarawak.[9] Li Jun's younger brother, Li Qiang, was Wong's partner who signed agreements together with Wong for recruiting Fuzhou immigrants in Sarawak and contributing to the development of Sibu.[10] Li Qiang also served as the chief editor of *Penang Sin Bao* (《槟城新报》) and was recognized as one of the prominent poets mentioned by Khoo Seok Wan (邱菽园, 1874–1941).[11]

In 1891, Li Jun visited Singapore for the first time at the invitation of prominent Chinese merchant Goh Siew Tin (吴秀珍) to treat his father, Goh Siew Swee (吴秀水), a Fujian-born businessman involved in wholesale trade and shipping (Note 3).[12] Li Jun's treatments were


ANATOMY

DESCRIPTIVE AND SURGICAL.

BY

HENRY GRAY, F.R.S.

THE DRAWINGS

BY H. V. CARTER, M.D.

THE DISSECTIONS

JOINTLY BY THE AUTHOR AND DR. CARTER.

LONDON:

JOHN W. PARKER AND SON, WEST STRAND.

1858.

Figure 1 In 1880, Dr. Osgood translated *Gray's Anatomy* into Chinese as *Quan Ti Chan Wei* (《全体阐微》 *Anatomy, Descriptive and Surgical*) [source with permission from: Internet Archive (Public Domain)]

effective, earning him a strong reputation within the local Chinese community. During his stay in Singapore, he met the Chinese consul, Tso Ping Lung (左秉隆, 1850–1924), and joined his literary society, *Hui Xian She* (会贤社, the Society for the Meeting of Literary Excellence).[6]

By the time Li Jun visited Singapore, the first Chinese medical institution, Thong Chai Yee Say (同济医社), had been founded in 1867 by Chinese leaders Ho To Seng (何道生) and Liang Jiongtang (梁炯堂), with later support from the protector of Chinese and Chinese consul Tso. With a growing number of patients, the institution recorded 39,196 annual visits by 1891. Due to the increasing demand for services, it relocated in 1892 and was officially renamed *Thong Chai Medical Institution* with the endorsement of the Governor of the Straits Settlements, Sir Cecil Clementi Smith.[13] During his visit, Li Jun met Yeh Chih Yun (叶季允, 1859–1921), the chief editor of *Lat Pau* (《叻报》), Singapore's earliest Chinese newspaper. Yeh excelled in poetry, arts, and Chinese medicine. Li Jun declined Yeh's invitation to manage Thong Chai Yee Say.[6] In the subsequent months, Li Jun traveled to Kuala Lumpur, Penang, and Sumatra, documenting his observations in *Bin Lang Yu Zhi Lue*. He also compiled his medical experiences in Singapore into *Xin Mao Yi An* (《辛卯医案》*Xinmao Medical Cases*).

Li Jun engaged with important local Chinese leaders and interacted with classical Chinese poets and physicians during his stay in Penang. He was highly regarded in the local community not only for his exceptional medical expertise but also for his remarkable artistic talents. Upon his return to China, Tso Ping Lung wrote eight poems in his honor, six of which were documented in his book titled *Zuo Zi Xing Ling Shi Song Bie Shi Wu Gu* (《左子兴领事送别诗五古》*Consul Tso Ping Lung's Farewell Poems in Five-character Ancient Style*). In these poems, Tso gave very high praise for Li Jun's talent, medical skills, perseverance, diligence, and outstanding contributions.[3]

Li Jun even learned Western medical techniques from local physicians, focusing on pain relief, deworming, skin irritation, and wound healing. In 1893, he returned to Penang and established the Chinese and Western Medicine Research Society (中西医药研究社) with the support of Tso Ping Lung, which was regarded by some as the first institution of its kind.[6]

2.3 The monograph on Penang Island

Before traveling to Nanyang, Li Jun's knowledge of foreign lands came from books such as *Ying Huan Zhi Lue* (《瀛环志略》 *A Brief Account of the Maritime Circuit*) and *Shi Xi Ji Lue* (《使西纪略》 *A Brief Account of an Embassy to the West*). In Singapore, Tso Ping Lung introduced him to his work, *Hai Nan Qun Dao Ji Lue* (《海南群岛纪略》 *A Brief Record of the Hainan Archipelago*), further deepening Li Jun's understanding of the Malay Peninsula.

In *Bin Lang Yu Zhi Lue*, Li Jun meticulously documented his travels and observations on various aspects of Penang and the Malay Peninsula. Following the traditional Chinese gazetteer format (地方志) in its compilation, the book is divided into ten volumes: *Astronomy*, *Geography*, *Officials and Envoys*, *Exiles*, *Monuments and Notable Sites*, *Architecture, Customs*, *Arts and Literature*, *Finance and Economy*, and *Miscellaneous Discussions*. Spanning ten volumes, the monograph provides a comprehensive account of Penang and the broader Malay Peninsula during that period (Fig. 2).[14]

By the time Li Jun visited Penang Island, it had maintained its importance as a major trading center for

Figure 2 Photo of Li Jun and *Bin Lang Yu Zhi Lue* (《槟榔屿志略》*The Monograph on Penang*) (source with permission from: Center for Southeast Asia Study, Xiamen University)

international shipping routes. Under British administration, Penang served as a magnet for merchants and traders from Asia and beyond. Chinese immigrants were particularly encouraged to settle in Penang, as they were considered by Francis Light, the founder of the British colony, to be "a valuable acquisition".[15] From 1871 to 1881, Penang and the Province Wellesley's population grew by 30.1%, with the Chinese population rising from 36,382 to 67,820, a 46.36% increase, the highest among the three British settlements. By 1891, Penang's population had reached 235,618, with Chinese accounting for about 38%.[16] The rapid population growth that resulted from the booming economy led to high demand for health facilities and care services.

In his extensive narrative, Li Jun devoted special attention to the status of Chinese medicine on Penang Island, particularly in the sections titled "Lam Wah Ee Hospital (南华医院)" and "A review on Penang medical services (槟城医话)". In these chapters, he critically examined the healthcare landscape and the evolution of TCM in Penang. Li Jun's observations were notably insightful, establishing his work as the earliest and most comprehensive analysis of the development of TCM in Penang during the late 19th century.

3 Narratives of Lam Wah Ee Hospital (南华医院)

Penang became the site of the first Chinese herbal hall in Malaya. A decade following Francis Light's establishment of the settlement in Penang, the first Chinese medicine hall, Yin Oi Tang (仁爱堂) commenced operations in 1796.[17] This marked a significant early establishment of TCM in the region. The influx of Chinese immigrants drove local demand for TCM, and more importantly, the emergence of wealthy Chinese businessmen made charitable Chinese medicine possible. The 1860s marked a pivotal shift with the establishment of TCM hospitals, which allowed for greater patient capacity and the start of professional TCM services in Malaya. Among the earliest TCM hospitals in British-ruled Malaya were the Singapore Thong Chai Medical Institution (新加坡同济医院), Chha Yong Fay Choon Kuan (茶阳回春馆), Tung Shin Hospital (同善医院), and Lam Wah Ee Hospital.[18]

To cater to the increasing demand for TCM, the idea of setting up a community healthcare institution in Penang was first mooted by a few Chinese community leaders in 1876, leading to a fundraising campaign. By 1883, a traditional-style building was completed on a 10,600-square-foot plot of land on Muntri Street, marking the founding of Lam Wah Ee Hospital.[19] Initially, the original founding committee managed all affairs until 1885, when leaders from both the Fujian and Guangdong communities joined to form a new committee.[20]

Despite its century-long significance and contributions to local healthcare, much of Lam Wah Ee Hospital's archival records were lost or damaged during World War II. The annual donation records (征信录) played a vital role in documenting the hospital's development, detailing its governance, organization, services, income (primarily from donations), and expenditures. While the hospital published donation reports annually, only four pre-war volumes (1928, 1933, 1939, and 1940) have survived, along with reprinted versions of the hospital's constitution after the war.[21] Li Jun documented the architecture design, his couplets, and seven prefaces to the Hospital donation records from 1883 to 1890, providing a glimpse into the hospital's founding background, mission, environment, and medical services. *The Preface to the Annual Record of the Lam Wah Ee Hospital's Inaugural Year* (1883–1884) described the background and mission of the endeavor. As it recorded:

> "The establishment of the hospital began in the summer of the Guiwei year (1883), with regulations formulated following the model of Tung Wah Hospital. Since the island came under Western jurisdiction, attracting merchants in great numbers, the initiators' benevolence has been immeasurable. However, during the founding period, divergent opinions were prevalent. Despite our limited capabilities, we reluctantly assumed this significant responsibility, dedicating ourselves to diligent service while disregarding personal gains and losses.
> 医院之设创，自癸未夏。所定章程，仿东华医院。盖屿自西辖，客商云集，倡之者惠莫大焉。然而创始之际，立说多歧。某等谬以菲材滥膺钜任，只有黾勉从事，而利害公私有所弗计。
> A suitable site was selected, artisans were hired, and the structure was constructed in the traditional Chinese architectural style. Virtuous gentlemen, who take pleasure in charitable acts, generously donated funds, with contributions exceeding ten thousand individuals. This exemplifies how benevolence inspires collective success, achieving what previous generations could not. Since its founding, the hospital has been devoted to treating illnesses, assisting the poor, and providing free medicines and medical services to the extent of its capabilities. It has now been a year since its establishment.
> 于是择地鸠工，堂室规模一如华夏，弥月落成。诸君子乐善轮捐，计万有余员，可见善心感发，相与有成，为前人所不能为。从此拯疾病，惠贫困赠药赠医，凡所当行者量力行之，迄今一载。"[3]

The Prefaces to the Records of Lam Wah Ee Hospital for the years 1885 to 1890 provide insight into the environmental conditions, prevalent diseases, and challenges faced by the local residents. The hospital records in 1886 and 1887 highlighted:

> "In the coastal regions where overseas Chinese resided, there were frequent occurrences of ailments caused by wind and dampness. Laborers working in the wilderness often could not avoid the harm caused by smoke. Whether it was heat or cold, the symptoms varied. Whether nourishment or purging was needed, treatment was not straightforward. Therefore, arrangements were made to invite physicians to provide consultations at various locations.
> 海峤侨居，时有风邪之中。荒山傭力，难免烟障之侵。或暑、或寒，症非一类。宜补、宜泻，治亦难齐。于是设席延师，分局就诊。

> Penang's transient population continues to grow, and so does its permanent population. Illnesses caused by climatic changes and emotional disturbances are inevitable, and the poor suffer the most. The hospital can only adhere to its established regulations, striving to fulfill its responsibilities without failing in its duties.
> 槟城流寓日多，生齿日盛。六气之感，七情之伤，病者固所不免，贫者尤为可怜。惟有率由旧章，以期无忝厥职。"[3]

Lam Wah Ee Hospital was depicted as essential for delivering medical care in a coastal town susceptible to harsh weather conditions. The narratives emphasize the critical need for free medical treatment to prevent disease transmission and reduce mortality rates. To address these concerns, the hospital actively invited skilled physicians with relevant specialties, thereby enhancing its capacity to provide effective healthcare. The records from 1889 and 1890 provide an indirect commendation of the hospital's healing capabilities and specialized expertise:

> "Since its establishment, the hospital has utilized all four diagnostic methods to discern underlying issues related to cold, heat, yin, and yang. By adhering to the six-channel theory of *Nei Jing* (《内经》*The Inner Classic*), it has systematically categorized treatments and adeptly managed conditions of warmth, coolness, dryness, and dampness, tailored to individual cases.
> 本医院倡建以来，四诊兼施，辨寒暑阴阳之偶伏；六经分治，合温凉燥湿而咸宜。"[3]

The records highlight the community's generous contributions, with Li Jun praising the hospital's services and charitable culture (Fig. 3). He noted that, like Singapore's Thong Chai Medical Institution and Hong Kong's Tung Wah Hospital, Lam Wah Ee Hospital serves as a charitable hall, supported by local initiatives. Particularly, Lam Wah Ee Hospital has adopted its management model, treatment practices, and physician examination system following Tung Wah Hospital. The open examination process required candidates to gather at Lam Wah Ee Hospital, where they were tasked with addressing topics and demonstrating their skills in pulse diagnosis and medical theory. The submissions were sealed and sent to senior physicians at Tung Wah Hospital for evaluation. Among the candidates, the five candidates who exhibited the highest levels of skill and character were chosen for appointment.[22]

Li Jun even documented five articles by the attending local physicians of the Hospital's examination in his book. Among these were five submissions on the topic "On treating warm diseases without inducing sweating (问治湿温不可发汗说)", prepared for Lam Wah Ee Hospital's open examination. The top-ranking physician, Huang Chun Qiao (黄春翘), emerged as the champion and was subsequently appointed as the chief physician of the hospital.[3] These valuable early records underscored Lam Wah Ee Hospital's dedication to community service and its adaptability to the evolving healthcare landscape, establishing a foundation for its ongoing growth and importance in Penang's medical history.

Figure 3 Lam Wah Ee Hospital in Penang offers TCM and Western medicine, and its original building was destroyed in World War II (source with permission from: photo taken by the author)

In the following decades, Lam Wah Ee Hospital expanded its charitable services beyond TCM. Starting in 1910, the government designated the hospital to administer cowpox vaccinations to the local population. Patient numbers steadily increased, peaking in 1940 when over 57,454 medications were dispensed in a single year.[23] This data illustrates the hospital's pivotal role and strong presence in the community during this period, aligning with Li Jun's praise: "Fortunately, millions of people in the archipelago have been granted their well-being, all thanks to the benefactors (且幸群岛数百万生灵有所托命, 皆诸善长之赐也)".[3]

4 Critique of Chinese medicine in Penang

In addition to his records and comments on Lam Wah Ee Hospital, Li Jun's most important and valuable contribution in his book was his unique observation of Chinese medicine in Penang. In his 1200-word article, "A review on Penang medical services", Li Jun provided insightful perspectives on the status of Chinese medicine services during that period. His article analyzed and identified the major challenges confronting Chinese medicine in the region from various perspectives. These challenges included a shortage of experienced physicians, inconsistent quality and availability of raw herbal materials, the prevalence of unique disease patterns, and the influence of diverse cultural practices among different ethnic groups.

4.1 Challenges faced by TCM physicians

First of all, Li Jun addressed the challenges faced by TCM practitioners with clarity and precision, identifying key issues that stemmed from the physicians' own limitations. As he pointed out:

> "In the practice of Chinese medicine, there are still those who adhere to Confucian principles. Many who have crossed the seas come from impoverished backgrounds and possess only superficial knowledge. They rashly engage in medical practice, often leading to mediocrity and inadequate understanding, which is the first limitation of medicine.
> 中国习医，尚有儒者。浮海而来，多为贫迫，粗识之无，贸然行道，庸劣多则理不明，限于医一也。"[3]

The primary reason was the immigrated physician's background. Experienced TCM practitioners were traditionally trained and respected as "Confucian physicians (儒医)", enjoying higher income and social status. In contrast, most Chinese migrants to Nanyang in 19th century were impoverished individuals, with few among them being medical experts. According to the Straits Settlements census in the year of 1881, there were 188 Chinese medical practitioners in the state, including physicians, dentists, and herbalists, representing 48% of the total medical occupations across all ethnic groups.[17] This proportion was significantly higher than that of the Malays, Tamils, Europeans, and other indigenous peoples. However, properly qualified Chinese medicine physicians, known as "Sinseh (先生)", were scarce in the Straits in the 19th century, and superstition in medical practice enabled temple mediums, akin to witch-doctors, to thrive.[6]

Li Jun underscored significant ethical and behavioral concerns among local physicians, noting that many prioritized profits over evidence-based practices, often making unrealistic promises of cures, which resulted in widespread deception and a scarcity of genuine skills. He reinforced:

> "Lacking proper education, they resort to simplistic methods, copying and modifying prescriptions at will, mixing treatments indiscriminately, and focusing solely on profit. Deception is prevalent, obscuring genuine practice, which is the second limitation of medicine. Engaging in petty and unscrupulous behavior, they seek to please the wealthy while demeaning those of lower status, resulting in a lack of respectability, which is the third limitation of medicine. With one blind leading many, erroneous practices spread, forming factions that attack dissenters and engage in slanderous speech. This leads to a lack of unified authority, which is the fourth limitation of medicine.
> 素不知学，因陋就简，钞袭类方，任意加减，寒凉补泻，错杂混施，包治限期，惟利是视，巧伪多则真不见，限于医二也。猥琐龌龊，奔竞为能，取悦富人，下同贱役，卑鄙多则品不尊，限于医三也。一盲引众，谬种流传，党同伐异，肆口讪讅，攻击多则权不一，限于医四也。"[3]

The traditional Chinese notion of the "Confucian physicians" underscores the importance of not only professional expertise and knowledge but also cultural refinement and moral principles. "Sincerity" and "integrity" are fundamental aspects of Confucian ethics, with traditional physicians held to the highest standards of medical ethics and conduct.[24] Li Jun criticized the inclination of some physicians to prioritize wealthy patients while neglecting the poor, engaging in actions that undermined the dignity of the profession due to inadequate ethical standards. This criticism reflects his strong emphasis on and demands for medical ethics and morality.

4.2 Challenges in herbal medicine

Li Jun highlighted several critical issues affecting Chinese herbal medicine, particularly regarding the availability, quality, and manufacturing of raw materials. The six major issues he identified are:

a) Preparation method variability: It's advisable to use powder for problems of the upper jiao, pills for problems of the middle jiao, syrup for flowers, gelatin for peels, etc. Different methods of preparation can lead to reduced efficacy due to inconsistency in processing techniques. However, when sought in the community, these preparations are often unavailable. The lack of effectiveness is due to differences in preparation methods, which is the first limitation of medicine (上焦宜散，中焦宜丸，诸花宜露，诸皮宜胶，六神宜麴曲，陈皮宜酱，兔丝宜饼，桑葚宜膏，古人立法，具见深心。入市而求，皆未有备。因服法异而不效，限于药一也).[3]

b) Production technique: It's advisable to process *Chai Hu* (柴胡 Radix Bupleuri) with honey, *Zhu Ru* (竹茹 Caulis Bambusae in Taenia) with ginger, to fry *Bai Zhu* (白术 Rhizoma Atractylodis Macrocephalae) and *Yi Mi* (薏米 Coix Chinensis) with oven earth, and fry *Shan Zhi* (山栀 Fructus Gardeniae) aswell as *Du Zhong* (杜仲 Cortex Eucommiae) until it became dark. Proper adherence to traditional methods is crucial for maintaining the intended therapeutic benefits. The issue arises when these specific preparation techniques are not adhered to, leading to variations in the medicinal properties and effectiveness of the herbs (柴胡用蜜，竹茹用姜，白术、薏米皆用土炒，山栀、杜仲皆用黑炭，因炮制异而不效，限于药二也).[3]

c) Geographical substitution: Using substitutes from different regions, like Sichuan magnolia bark replaced by Pucheng hazel bark, immature bitter oranges from Jiangnan (江南 regions south of the Yangtze River) by dry tangerine from Fuzhou, can affect the medicinal quality and effectiveness due to variations in origin (四川厚朴代以浦城榛皮，江南枳实代以福州桔干，参非上党，连非雅州，因地道异而不效，限于药三也).[3]

d) Material differences: Variations in the intrinsic properties of materials, such as the distinction between Sichuan and Zhejiang fritillary, the bitter versus sweet varieties of apricot, the different parts of poria (skin and core), or the root and stem of ephedra, can significantly impact medicinal effects (贝有川、浙，杏有苦甘，茯苓皮心，麻黄根节，名同实异，不可不知，因物性异而不效，限于药四也).[3]

e) Quantity discrepancies: Inconsistencies in packaging and measurement practices can lead to incorrect dosages, impacting the effectiveness of herbal treatments. For example, expensive materials like amber and pearls may be reduced in quantity, while cheaper items like hawthorn and malt may be increased (药无另包，戥难再核，琥珀、真珠价贵减少，山查、麦蘖价贱增多，因分两异而不效，限于药五也).[3]

f) Nomenclature confusion: Mislabeling or misinterpretation of names, leading to incorrect substitutions, can cause ineffective treatment due to the use of inappropriate ingredients. When names coincidentally match, substitutions are made, and when materials are unavailable, arbitrary replacements occur. Differences in flavor and properties result in ineffectiveness, marking the sixth limitation of the medicine (枳壳书作只壳，但取偏旁，桑枝书作双其，竟同假借，方字多歧，药品易乱。尝见泻白散桑白皮以丹皮代之，银翘散忍冬花以款冬代之，名偶同则互相更易，物未备则随意混充，气味异而不效，限于药六也).[3]

Wang Gungwu has noted that the trade in medicine has long been a significant aspect of commerce between the Malay Peninsula and China.[25] From the late 19th century onward, medicine trade between the Straits Settlements and overseas regions experienced steady growth. However, suppliers often struggled to meet the escalating demand. Li Jun highlighted the common practice of providing physician consultations at Chinese herbal medicine halls to ensure the careful selection of medications. Given the deeply interconnected and complementary nature of healing and herbal treatments in TCM, his analysis of the challenges facing herbal medicine in Penang was both critical and significant, offering insights applicable to other areas of the Malay Peninsula.

4.3 Overcoming cultural and ethnic barriers

Since its establishment, Penang has become a vibrant melting pot, embracing multiculturalism with diverse ethnic and religious groups, including major Chinese, Malay, Indian, Peranakan, Eurasian, and Siamese communities, alongside notable minorities.[26] In his analysis, Li Jun highlighted seven critical challenges faced in treating patients, particularly the diverse cultural practices among different ethnic groups, which could result in mistreatment or ineffective results.

Firstly, a prevalent issue is the misuse of medication. Patients often turn to heavy medicines for minor ailments due to Western influences, which can exacerbate their conditions. Li Jun noted that being under British rule had accustomed the local population to Western customs. Consequently, patients frequently seek advice from Western-trained doctors for minor issues, sometimes opting for unnecessary high-potency medication, potentially worsening their health. Moreover, using specific treatments for complex conditions can lead to imbalances or ineffective outcomes (地属英辖，人狃西俗，偶患沙喆即问老公。轻症而用重药，或致陷邪。兼症而用专方，亦虞偏胜。此为病者所限一也).[3]

The second issue involves family interference in treatment, particularly from relatives of different ethnic groups. These family members may have their own traditional remedies for symptoms such as mild diarrhea or constipation, which are unsuitable for sweet-property formulas; and it is especially contraindicated for pungent, warm-heat conditions. Such interference can prevent the proper management of the patient's condition, representing a significant limitation in healthcare provision (所娶娘兄，本属番族，新挈轻泻燥结，不宜甘蜜。辛温热症尤忌。我刚议治，彼又施方，掣肘不知，噬脐何及。此为病者所限二也).[3]

The third challenge is the influence of superstitious beliefs and practices, which are particularly common in southern populations and even more so overseas. Practices such as witchcraft, magical charms, and the use of spiritual potions can have harsh, detrimental effects on the body, easily damaging vital energies, making it difficult to administer effective medical treatment (南人好鬼，海外尤甚，降头符药，庵公神丹，燥烈之性，易伤精液。巫觋演法，多就卧房，跳掷喧呶，易扰魂魄，劫阴越阳，皆难施治。此为病者所限三也).[3]

The fourth limitation arises from environmental and lifestyle factors related to living near the equator, where summer conditions prevail most of the year. These habits can result in wind-cold and dampness affecting the body's wei-defensive qi, phlegm accumulating in the chest, suggesting the need for treatments that disperse and alleviate these conditions. Additionally, there is a tendency to rely on warm and tonic supplements that can exacerbate existing ailments by retaining pathogenic factors, mistaking real conditions for deficiency (地近赤道，时多夏令，汗后濯水，醉后饮冰，饭后啖果，茶后裘凉，风湿伤卫，痰涎壅膈，法宜辛散。喜服温补，留邪增剧，实疑为虚。此为病者所限四也).[3]

The fifth issue concerns the impact of the hot climate on the body's vital energy. The intense heat can deplete the body's essential energy, often leading to conditions such as coldness in the spleen and kidneys and dryness in the stomach. This, coupled with new contraction of latent pathogenic qi in Moyuan (pleurodiaphragmatic interspace), may gradually affect Fu-organ disorders. This condition should be treated with cold/cool-property medicines. Warm-heat medicines may lead to yang depletion and incurable. This highlights the critical need for aligning treatment approaches with the environmental context and the specific needs of the patient's condition (地热欲炽，真元必亏，脾肾多寒，脯胃多燥，新感伏气，半在膜原，失治传变，渐成腑病。法宜寒凉，喜服温热，至于亡阳，无可救药。此为病者所限五也).[3]

The sixth limitation involves the consumption of certain foods and substances that can exacerbate health issues. The use of fragrant tobacco from Luzon, flavorful wines from France, warm-natured ginseng, and pungent cinnamon, along with roasted meats and spicy foods

like ginger and pepper, are common among the wealthy. These foods and substances may generate hidden fire, which further cause warm to be warmer, dry to be drier, and heat to be hotter, leading to false cold symptoms, followed by blood loss, yang depletion and even death. This highlights the danger of misdiagnosing and mistreating conditions due to dietary habits and the importance of understanding the effects of food and drink on health （吕宋烟香，法兰酒旨，人参性温，玉桂气烈，燔炙腥膻，姜椒辛辣，富人供养，火毒早伏，感温愈温，感燥愈燥，热极而厥，反疑寒象，血溢阳亡，枉死无数。此为病者所限六也).[3]

Lastly, substance abuse is rampant, with widespread opium among men and betel nut among women, leading to severe depletion of essence and blood, leading to wet dreams and making it difficult to restore health. This highlights the profound impact of substance use on health and the challenges it poses to recovery and treatment (男子鸦片，妇女槟榔，十人而九。精耗血伤，精耗梦泄，血伤病经，补不敌破，元气难复。此病者所限七也).[3]

These challenges underscore the complex interplay of cultural, environmental, and lifestyle factors in medical treatment, emphasizing the need for culturally sensitive healthcare approaches that consider these diverse influences. Understanding these dynamics is crucial for healthcare providers seeking to deliver effective treatment and improve patient outcomes in such multicultural settings.

Medical sociology has experienced significant growth worldwide over the past century. The earliest work was undertaken by physicians instead of sociologists. The term "medical sociology" was first introduced in 1894 by Charles McIntire, who highlighted the significance of social factors in health within a medical article.[27] According to existing literature, Li Jun was probably the first Chinese medicine physician to explore health and medicine overseas through a medical sociology perspective. He addressed the differences in health by racial and ethnic, pointing out the factors such as different physical constitutions, behavior, diet, religious faith, and lifestyle, which making the medication results varied. His observations provided valuable insights by linking societal and cultural elements to medical practices. The tropical climate in Penang is hot and humid. Li Jun's analysis on health situation and medical treatments in Penang and Malaya was deeply rooted in his knowledge and experiences, particularly his academic foundation in the theories of *Shang Han* (伤寒 cold damage) and *Wen Bing* (温病 warm disease).[28]

Li Jun recognized the multifaceted nature of the medical profession, proposing that his writings could provide readers with a deeper appreciation of the challenges and sincerity integral to being a physician overseas. These challenges stem not only from the inherent complexities of medical practice but also from the limited availability of medical supplies and the diverse complexities presented by patients' conditions.

5 Conclusion

Li Jun was one of the few TCM masters who advocated and practiced integrated Chinese and Western medicine in the early 20th century China, and was regarded as "the first person who advocated the integration of Chinese and Western medicine both as an official and as a physician".[29] He was also a rare Chinese physician who have ever visited Southeast Asia, Japan, U.K. and Europe in early 20th century. In 1897, He completed his observations on Japan's medicine in the book *Ri Ben Yi Xue Diao Cha Ji* (《日本医学调查记》*An Investigation of Japanese Medicine*). *Huo Zhai Yi Mu* (《豁斋医目》*Medical Catalogue of Huozhai*) and more than 200 medical books that Li Jun brought back from Japan have become rare and valuable treasures for TCM study, many of which had long been lost in China. These works later served as important sources for *The History of Chinese Medicine* written by Wu Lien-Teh and K. Chimin Wong, and their significance has been increasingly recognized by scholars.[30]

In 1903, Li Jun relocated to Beijing, where he quickly garnered acclaim for his exceptional medical expertise. By 1906, he had ascended to the role of court physician, responsible for diagnosing ailments afflicting Empress Dowager Cixi (慈禧) and Emperor Guangxu (光绪). Despite his increasing prominence in Beijing, Li Jun chose to feign illness in order to resign from his prestigious position, opting instead for a life of seclusion. During this period, he devoted himself to the meticulous study of medical cases and prolific writing, remaining in isolation until his death in Beijing in 1925. Throughout his career, Li Jun made substantial contributions to the fields of medicine and social advancement, authoring over 40 significant academic works and playing an important role in introducing Western education to China (Note 4). His legacy includes a remarkable collection of ancient texts, with more than 800 out of the 1,325 housed at the Chinese Academy of Medical Sciences originating from his personal collection and scholarly endeavors.

The rapid expansion of plantation and mining industries in 19th-century British Malaya spurred economic growth and increased Chinese immigration, leading to a heightened demand for healthcare and the resources necessary to establish medical institutions. Penang, with its distinctive social environment, ethnic diversity, and substantial Chinese diaspora, particularly stands as a quintessential historical bastion for traditional medicine. As a comprehensive chronicle, *Bin Lang Yu Zhi Lue* provides detailed records of Penang's late 19th-century society, including its astronomy, geography, politics, economy, and culture. The academic value is comparable to that of renowned writer Isabella Bird (1831–1904), whose *The Golden Chersonese* (1883) provides one of the most

compelling narratives of life in British Malaya.[31] The two works offer distinct Eastern and Western perspectives, complementing each other in their study of British colonial Malaya.

TCM played a vital role in meeting the healthcare needs of the Chinese community, yet its historical development in overseas Chinese society remains underdocumented. Li Jun was the most experienced Confucian Chinese medicine physician to visit Malaya Peninsula in the late 19th century, as documented in historical records. Not only did he introduce and promote Chinese medical treatment techniques through his clinical practice, but he also observed and documented local medical practices, prevalent diseases, and health conditions. With deep experience in both the theory and practice of Chinese medicine, Li Jun's insightful perspective reveals the complexities in the adaptation and provision of Chinese healthcare within the diaspora, offering a nuanced critique of its challenges, and underscores the importance of charitable medical practices in Penang and the Straits Settlements. It meticulously documents early TCM institutions and the status of overseas physicians and their practices, preserving rare literature and filling a gap in the historical analysis of TCM's overseas development during the era.

Notes

1. There are conflicting accounts of Li Jun's birth year, with some sources listing 1855 and others 1856. However, based on first-hand archival evidence, Mr. Wang Zongxin has determined that Li Jun was born on May 30th, 1856.
2. *Bin Lang Yu Zhi Lue* has not yet achieved a widely accepted English translation for its title. In 2024, French scholar Claudine Salmon published a brief introduction in French Journal *Archipel* in 2024. See: Salmon C. (Qing 清) Li Jun zhuan 力鈞撰, *Bin Lang Yu Zhi Lue Jiao Zhu* (《槟榔屿志略校注》 *Annotated Records of Pulau Pinang*). Nie Dening (聂德宁), Yon Weng Woe (阮湧俙), eds. Xiamen, China: Xiamen University Press; 2022. *Archipel*. 2024;107. In *Cultural Transplantation: The Writing of Classical Chinese Poetry in Colonial Singapore (1887–1945)*, published in 2023 by Singaporean scholar Lap Lam, Li Jun's *Bin Lang Yu Zhi Lue* is mentioned in English as *Brief Records in Penang*. For the sake of clarity in English academic discourse, this article adopts the *translation Bin Lang Yu Zhi Lue: The Monograph on Penang* for Li Jun's work. It should be noted that another book with a similar title, also called the same name in Chinese "《槟榔屿志略》", was authored by Yao Nan (姚枏) and Zhang Liqian (张礼千) and published by the Commercial Press in 1946.
3. Goh Siew Tin (吴秀珍, 1854–1909) was born in Shao'an, Fujian, in 1854. He migrated to Singapore, where he joined his father, Goh Siew Swee (吴秀水, ?–1892), in the family business. In 1898, Goh Siew Tin was appointed as a committee member of the Singapore Po Leung Kuk. He further distinguished himself in 1906 by co-founding the General Chinese Trade Affairs Association—later known as the Singapore Chinese Chamber of Commerce—together with other prominent members of the Chinese community. Goh served as the association's first president, became vice-president in 1907, and resumed the presidency in 1908.
4. Li Jun made significant contributions to education, and his family's achievements are equally noteworthy. His eldest son, Li Jiahe, was a pioneer in translating TCM and studied in Japan, where he authored *Li Shi Ling Yan Ben Cao* (《力氏灵验本草》 *Li's Miraculous Materia Medica*) in 1930. His second son, Li Shudong, pursued medical studies in the United States and eventually became vice president of the Chinese Medical Association. Li Jun himself played an important role in introducing Western education to China. He co-founded the Cangxia New Style School (苍霞精舍), which later developed into the Fujian University of Technology (福建工程学院), and established the Dongwen School (东文学堂), a school emphasizing Japanese language studies that served as the precursor to Fujian Normal University (福建师范大学).

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Author contributions

SU Qiuyang collected archives, data and wrote the manuscript. Danny Tze-ken Wong and Tan Miau Ing reviewed the manuscript.

Conflicts of interest

The authors declare no financial or other conflicts of interest.

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Feature Article

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Traditional Chinese Medicines along the Silk Road: The Spread of Cinnamon and Its Knowledge of Medical Applications

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Abstract

Cinnamon was a significant commodity in the spice trade along the Silk Road and was popular throughout Asia, Europe, and Africa, where it has been widely used in medicine, religion, and daily life from ancient times to the present day. This paper examines the ancient literature related to cinnamon from a global perspective, exploring its origins, spread, and medicinal uses documented in various traditional medicine. It aims to uncover the exchange of medicinal knowledge among civilizations along the Silk Road and the contribution of traditional Chinese medicine (TCM) to medical practices worldwide. The findings indicate that China and Southeast Asia were the primary sources of cinnamon used in the West during ancient times, with Persian and Arab traders playing a crucial role in its transmission from East to West. The common and unique applications of cinnamon in various medical traditions illustrate the dynamic flow of medicinal knowledge across regions and highlight the distinct strengths and characteristics of traditional medicines shaped by diverse cultural backgrounds. Taking cinnamon as an example, this study demonstrates how the westward spread of traditional Chinese medicines promoted the exchange and integration of medical knowledge among countries along the Silk Road. It contributes to understanding the patterns of medical knowledge dissemination between the ancient East and West, with medicines as the carrier for cultural exchange.

Keywords: Silk Road; Traditional Chinese medicines; Cinnamon; Transmission of medicine; Medicinal knowledge

1 Introduction

The Silk Road, a series of trade routes connecting China and the Mediterranean Sea through India, Central Asia, and West Asia, facilitated the exchange not only of goods but also of cultural and medical knowledge. Since the Qin and Han dynasties, traditional Chinese medicines have been transferred along the Silk Road (by land and by sea) to many areas in Asia, Europe and Africa,[1] significantly contributing to medical development and improving public health in different countries. However, due to the lack of relevant historical records and language barriers, research on the westward dissemination of traditional Chinese medicine (TCM) remains limited. Current research primarily focuses on the influence of Persian, Indian, and Central Asian medicine on China via the Silk Road.[2] Since cultural communication is inherently bi-directional, it is worthwhile to explore the outward transmission of TCM.

Cinnamon has a long history of applications throughout the world, particularly as a spice and a valuable commodity on the Silk Road. In China, it has been an important aromatic herb, seasoning and herbal medicine since ancient times, and its use has also been documented in ancient Egypt,[3] Greece, and India. In modern botany, cinnamon belongs to the Lauraceae family, with two principal species: Cinnamomum cassia, native to Guangdong (广东) and Guangxi (广西) provinces of China and is also distributed in Vietnam, and Cinnamomum verum, endemic to Sri Lanka. Other species, such as Cinnamomum burmanni and Cinnamomum tamala, are also used as cinnamon substitutes.

Recent research on cinnamon has focused on phytochemistry and pharmacology, revealing that it contains cinnamaldehyde, cinnamic acid, and cinnamate, and has antioxidant, anti-inflammatory, antidiabetic, anticancer, antimicrobial, lipid-lowering, and cardiovascular benefits. It is also effective in the treatment of type 2 diabetes and neurological disorders.[4,5] In contrast, fewer studies

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have addressed the origins, historical spread, and medicinal value of cinnamon. In *Sino-Iranica* (1919), Berthold Laufer held that the cinnamon known to Semites, Egyptians, and Greeks in Herodotus' time, or earlier, likely did not originate from China or Indochina, but was primarily sourced from Ceylon and India.[6] Yamada Kentarō (山田宪太郎) explored the history of cinnamon in the third part of his monograph, *A Study of the History of Perfumery and Spices in the Far East* (《东亚香料史研究》), published in 1976. He thought that cinnamon was produced in regions east of India, namely Southeast Asia and the South China Sea.[7] This article explores the origins and dissemination of cinnamon, while examining its medicinal value across cultures. It aims to contribute to the study of exchanges between TCM and other medical traditions, and the transmission of medical knowledge along the Silk Road.

2 The source and spread of cinnamon

According to ancient Egyptian documents, as early as the 16th-13th century BCE, the queen of Egypt's eighteenth dynasty received cinnamon wood and other spices from Punt (modern Somalia).[8] For the Greeks and Romans, the source of cinnamon was a mystery for a long time. Herodotus (c. 484–425 BCE) believed that cinnamon came from Arabia, brought by the Phoenicians, and he recorded a myth about its source. Pliny the Elder (23–79 CE) proposed that it came from Aethiopia (an ancient Greek geographic term for the area around the Gulf of Aden) and was brought to the sea on rafts by Trolodytes.[9] Dioscorides argued that the best kind of cassia was called mosyllitic, which came from Mosyllum (in the Somali region). *The Periplus of the Erythraean Sea* "is the first record of organized trading with the nations of the East",[10] which was written in the 1st century CE. It goes, "There are shipped from the place (Mosyllum) a great quantity of cinnamon, so that this market-town requires ships of larger size".[10] The Roman geographer Strabo (64–23 BCE) held that cinnamon was abundant in southern India, in addition to Arabia and Aethiopia.[11] The plants of the Lauraceae family, with which we are now familiar, did not grow in Somalia or Arabia—regions generally considered the distribution center for frankincense, myrrh, and cinnamon. From these areas, these goods were transported to Europe. Then where did the cinnamon come from before it was shipped to this *regio Aromatifera* (region of spices)?

2.1 Cinnamon from the Orient

In Greek, *kinnamomon* (κιννάμωμον) and *kassia* (κασσία) are both for cinnamon, but the difference between the two words was not clear. Laufer argues that the two words are clearly of Semitic origin (related to Hebrew).[6] Persian name of cinnamon is *dār-chīn* (دار چین) or *dār-chīnī* (دار چینی), and *dār-sīnī* (دارصینی) in Arabic. *Chīn* means "China", suggesting the connection between cinnamon and China. Aly Mazahéri argues that *cinn-* in the Latin name cinnamomum is very reminiscent of *chīn* in Middle Persian language.[12] And there was another view, held by Muss-Arnolt, that cinnamon was called *khisi-t* in Egypt, possibly related to *kei-chi* (桂枝), or better *kei-shin* (桂心).[13] The above linguistic evidence suggests a Chinese origin for cinnamon.

Cinnamon is widely distributed in southern China, and historical records indicate that it has been used by the Chinese for centuries. In *Shan Hai Jing* (《山海经》 *The Classic of Mountains and Seas*), which was written between the Warring States period and the early Han dynasty, the distribution of *Gui* (桂) was recorded as "The mountain of Zhaoyao overlooks the western sea and is abundant in *Gui* (招摇之山，临于西海之上，多桂)".[14] Records in *Li Ji* (《礼记》 *The Book of Rites*) and *Shi Zi* (《尸子》 *The Corpse*) indicate that *Gui* was used as a condiment and aromatic material during Eastern Zhou (770–221 BCE).[15] The earliest classic on *Ben Cao* (本草 materia medica), *Shen Nong Ben Cao Jing* (《神农本草经》 *Shen Nong's Classic of the Materia Medica*), recorded two types of *Gui*: *Jun Gui* (菌桂) and *Mu Gui* (牡桂),[16] suggesting that it was used as medicine at the time. *Gui* is a phonetic-ideographic character, with "木 (wood)" indicating its meaning and "圭 (jade tablet)" as the phonetic component. *Gui Hai Yu Heng Zhi* (《桂海虞衡志》 *Records of the Officer of the Land of the Cassia Sea*) suggests that the formation of the character "桂" may be related to the unique leaf texture of the cinnamon tree.[17]

In the excavated texts, *Gui* appeared a dozen times in *Wu Shi Er Bing Fang* (《五十二病方》 *Formulas for Fifty-two Diseases*)[18] unearthed from the Mawangdui Han Tomb (马王堆汉墓). The script of *Wu Shi Er Bing Fang* was copied no later than the Qin and Han dynasties, and its content should be produced earlier than *Huang Di Nei Jing* (《黄帝内经》 *The Yellow Emperor's Inner Classic*). It is the oldest surviving medical prescription existing in China.[19] Also, in *Ju Yan Han Jian* (《居延汉简》 *Juyan Bamboo Slips of the Han Dynasty*) 89.20, *Shang Han Si Wu* (伤寒四物 four medicines for exogenous cold damage) contains *Gui* as one of the ingredients. It shows that before the Qin and Han dynasties, *Gui* had become a common medicine for treating diseases in the border regions of China. Given the time required for the recognition of a plant before its medicinal use, it is likely that the identification and utilization of cinnamon in China occurred much earlier.

So far, all the documentary evidence, both extant and unearthed, refutes Laufer's assertion that the early supply of cinnamon could not originate from China, which was predicated on his claim that the earliest reference to *Gui* appears in *Nan Fang Cao Mu Zhuang* (《南方草木状》 *Grasses and Trees in South China*) from the Jin dynasty.[6]

Yamada Kentarō pointed out that since cinnamon (and cassia) were mainly produced in India, Ceylon, southern China, the northern part of Vietnam, and Malaya, *chīn* or *chīnī* in Persian language should refer to the Orient, not just a certain Chinese product.[7] There are many goods named with "China" in Persian and Arabic, but this term denotes something different from modern China; it refers to all lands and islands to the east of India, including modern Malaysia and Sri Lanka.[20] The commentator of al-Biruni's work explains that because most of the goods were transported to Europe through the Persians and the Arabs, who received them from the hands of the Han Chinese, they neither knew where they came from nor where they originated from, but thought that the Han Chinese had brought them from China, so that in their language many goods named with "China", such as cinnamon, which, though it came from Ceylon, was called by Avicenna and Razes the wood of China and the wood from China.[21] Chen Ming (陈明) concurs that, according to modern botanical and pharmacological evidence, the medicinal items named sīnī/chīnī in Persian and Arabic literature do not necessarily have a Chinese origin or were traded from China at the time, but are symbols of a far and out-of-reach land, which can be categorized as "Chinese imagery" or the like. It can even be said that some of these items are "imagined" to be Chinese.[2]

Moreover, ancient literature contains no records indicating that cinnamon originates from Ceylon. The first recorded reference to cinnamon production in Ceylon dates no earlier than the 13th century, and its discovery may have been linked to the Chinese.[22]

2.2 The spread of cinnamon: from China to the West

The name of cinnamon frequently appeared in trade accounts along the Silk Road. The earliest record in ancient literature of China that refers to the outward spread of *Gui*, is found in *Mu Tian Zi Zhuan* (《穆天子传》 *Biography of King Mu, Son of Heaven*). *Mu Tian Zi Zhuan*, written during the Warring States period, recounts the trade activities of the Central Plains caravans to various regions of Central Asia, framed within the context of King Mu of Zhou's western tour. The items the caravans gave out along the way include *Jiang* (姜 Zingiber officinale) and *Gui* (桂).[23] Juyanzhi (居延置) was on the northern road from Chang'an (长安) to Dunhuang (敦煌), which was the main road on the eastern part of the Silk Road in the Han dynasty. The mention of *Gui* in *Ju Yan Han Jian* suggests that Chinese cinnamon may have been disseminated along the Silk Road to the Western Regions during that time.

In addition, there are fragments of medical documents unearthed in Turpan that record the prices of Chinese medicines, including *Gui Xin* (桂心), on the market of Jiaohejun (交河郡), a major town on the Silk Road during the Tang dynasty.[24] In the same period of time (7th-8th centuries), the Arabian Empire invaded Persia and became increasingly powerful; the Abbasid dynasty gradually expanded to the east, and eventually even controlled the Indus River as well as many areas in Central Asia that bordered the western frontier of the Tang dynasty. Arab, Indian and Chinese cultures interacted with one another, while trade between the north and south flourished, leading to a period of great prosperity along the Silk Road.[25]

Jaʿfar al-Ṣādiq (702–765 CE) was the first Muslim scholar to write about the trade of herbal medicine between nations in his treatise *Hadithal-Halila* (*Tradition of Myrobalan Fruit*), mentioned "cinnamon from China".[26]

The Persian scholar Ibn Khordādhbeh (c. 820–912 CE) is best known for his work *Kitab al-Masalik wa al-Mamalik* (*The Book of Routes and Kingdoms*), in which he identified cinnamon as a Chinese export.[27]

The 13th-century Arab geographer Yāqūtal-Hamawī (1179–1229 CE) noted in his *Mu'jam ul-Buldān* (*Dictionary of Countries*) that Djādjullā (哥谷罗 or 葛古罗 in Chinese, possibly located in present-day Trang, Thailand)[1] served as a trading center for Chinese cinnamon. Merchants transported cinnamon from China to this place before transshipping to the Arab region.[28]

Rashīd al-Dīn (1247?–1317 CE), the minister to Mahmud Ghazan (the seventh ruler of the Mongol Ilkhanate), compiled an agronomical and botanical book titled *Āthār va Aḥyā* (*Signs and Life*). This book documented the character and distribution of cinnamon (dārchīnī) in China. It also mentioned another variety with a soft texture called "qirfah (قرفه)" "found in India and parts of Qin", and noted that Chinese cinnamon "previously less imported [to the Iranian region], has increased today".[29]

The above historical records indicate that cinnamon was seen on the Silk Road in the early days of its formation, and Chinese cinnamon was traded to Persia and Arabia since the 8th century CE at the latest. As the French scholar Aly Mazahéri suggests, the Persian historical records indicate that cinnamon knowledge of West Asians which dates back to the early history of the Silk Road, developed together with that of ginger.[12] This aligns with the ancient Chinese practice of using ginger and cinnamon together, supporting the argument that the knowledge of cinnamon acquired by the West Asian was transmitted from China. And then, the cinnamon and its knowledge were further brought west by Persians and Arabs eventually to Europe.

3 The medical applications of cinnamon between ancient East and West

Cinnamon is mentioned in the medical writings of various ancient cultures, including TCM, Ayurveda, Greek medicine, and medicine in West Asia. By examining its

application in pluralistic medicines and identifying commonalities and distinctive characteristics, we can gain a clearer understanding of the global dissemination of cinnamon and its medicinal knowledge.

3.1 Cinnamon in traditional Chinese medicine

Jun Gui, *Mu Gui*, *Gui*, *Gui Zhi* (桂枝), *Gui Xin*, and *Rou Gui* (肉桂) are the names of cinnamon in TCM literature. *Jun Gui* should be derived from *Qun Gui* (囷桂), meaning "round cinnamon", and was later called *Tong Gui* (筒桂 tubular cinnamon). Some believe that "牡" is a mistake of "壮 (strong)", and *Mu Gui* is a mistake of "壮桂", which refers to the big ones. According to Wang and others,[30] there is no difference between *Gui*, *Jun Gui*, and *Mu Gui*, and the source plant should mainly be Cinnamomum cassia, though other species from the Lauraceae family or different families cannot be ruled out. Its medicinal parts have undergone a series of evolution, which can be briefly summarized as follows.

Before the Tang dynasty, the medicinal part was the bark of the large and small branches of the cinnamon tree, and it was called *Gui*, *Jun Gui*, *Mu Gui*. During the Tang dynasty, as *Xin Xiu Ben Cao* (《新修本草》 *Newly Revised Materia Medica*) says, "The bark of the tender branches of *Mu Gui* (cinnamon tree) is called *Rou Gui*, also known as *Gui Zhi* (其牡桂嫩枝皮名为肉桂，亦名桂枝)".[31] *Mu Gui*, *Gui Zhi*, *Gui Xin*, and *Rou Gui* are the same thing, and it is preferable to use the bark of tender branches with its outer layer removed. The Song dynasty witnessed the distinction between the medicinal parts of *Rou Gui* and *Gui Zhi*, with *Rou Gui* using the branch bark or small trunk bark, and *Gui Zhi* being the bark of the tender branches. During the Jin-Yuan period, the medicinal part of *Gui Zhi* gradually changed to cinnamon twigs, while *Rou Gui* took the trunk bark. The Song dynasty marks a turning point, after which the trunk bark and twigs became more commonly used in medicine, whereas previously, only the bark of the tender branches was utilized.

The textual research of *Gui Zhi* in the classical prescriptions has been a hot topic of discussion in recent years. Mayanagi Makoto (真柳诚) has proved that cinnamon medicine used in the prescriptions such as *Gui Zhi Tang* (桂枝汤 Cinnamon Twig Decoction) in *Shang Han Lun* (《伤寒论》 *Treatise on Cold Damage*), including *Gui*, *Gui Xin*, *Gui Pi* (桂皮), was changed into *Gui Zhi* by Office of Emendation Medical Books of the Northern Song Dynasty (北宋校正医书局). The medicinal part used then would have been the bark of the tender branches, not the twigs currently in use.[32] Regarding the herb selection for *Gui Zhi Tang* today, some scholars argue that the primary factor is whether to use bark or twigs. They conclude that cinnamon bark is the appropriate choice.[33] Another view attaches importance to the difference between branches and trunks, and believes that twigs are closer to the bark of the tender branches that the cinnamon medicine used at that time.[29] One researcher analyzed the chemical composition and the results showed that *Gui Zhi* and *Rou Gui* had similar chemical composition and effects, and the samples and the decoction of *Rou Gui* contained higher content of cinnamaldehyde than those of *Gui Zhi*. Since cinnamaldehyde is the main chemical constituent that plays the role of antipyretic, analgesic, and blood circulation, the results of the study do not support the conclusion that *Rou Gui* cannot relieve superficies syndrome.[34]

With the change of the medicinal parts of the cinnamon tree, the effects of this kind of medicine has been increased and clarified through the ages. In unearthed documents from the Qin and Han dynasties, such as *Wu Shi Er Bing Fang*[35] and *Zhi Liu Shi Bing He Ji Tang Fa* (《治六十病和齐汤法》 *Formulas for Treating Sixty Diseases and Harmonizing Decoctions*)[36] cinnamon is used in the treatment of surgical problems, such as trauma, abscesses, hemorrhoids, deep-rooted ulcer, etc., as well as internal diseases, such as cough, wind paralysis, muscular rheumatism, excessive thirst, prolonged diarrhea, etc., and is used in treating tooth decay and in the prescriptions that increase qi (Fig. 1, Fig. 2). The application methods include external application, fumigation, and internal use. In addition, there are two places

Figure 1 Original text of a formula containing *Gui* (桂) in *Wu Shi Er Bing Fang* (《五十二病方》 *Formulas for Fifty-two Diseases*) [source with permission from: *Compilation of Bamboo Slips and Silk Texts from the Han Tombs at Mawangdui, Changsha* (《长沙马王堆汉墓简帛集成》)[37]]

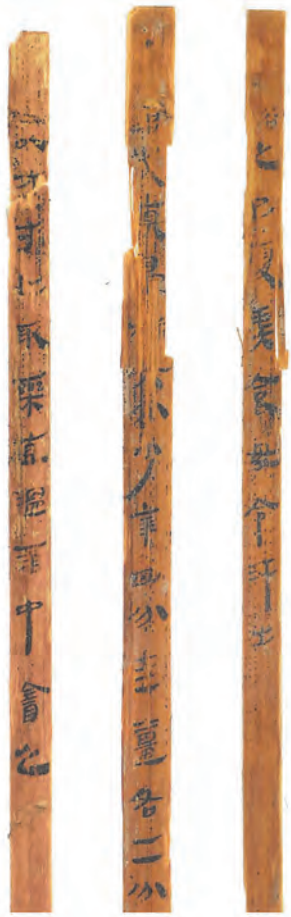

Figure 2 Original text of a formula using *Gui* ("圭", 桂) and *Jiang* ("薑", 姜) in *Zhi Liu Shi Bing He Ji Tang Fa* (《治六十病和齐汤法》 *Formulas for Treating Sixty Diseases and Harmonizing Decoctions*) [source with permission from: *Tianhui Medicine Slips (Upper Part)* (《天回医简·上》)[38]]

in *Ling Shu* (《灵枢》 *The Spiritual Pivot*) where *Gui* is used, both are for external use. One is "Apply *Bai Jiu* (白酒 white wine) and *Gui* on those who has tendon-muscle flaccidity (以白酒和桂，以涂其缓者)" in the chapter of *Jin Jing* (筋经). The other is in the hot medicinal compress therapy of needling cold paralysis with internal heat (刺寒痹内热), in the chapter of *Shou Yao Gang Rou* (寿夭刚柔).

Shen Nong Ben Cao Jing summarized the properties of *Jun Gui* and *Mu Gui*, describing them as pungent in taste and warm in nature. *Jun Gui* is mainly used for health and longevity, while the latter is used to treat illnesses, such as cough, throat obstruction, and joint discomfort. Tao Hongjing (陶弘景, 456–536 CE) expanded on the effects of *Mu Gui* in his *Ming Yi Bie Lu* (《名医别录》 *Supplementary Records of Famous Physicians*), where he first introduced its function of promoting sweating.[39] He also listed another cinnamon-based medicine, *Gui*, which can treat heart and abdominal cold and heat (心腹寒热), cold disease, cholera with muscular spasm (霍乱转筋), headache, lumbago, cough, and nasal blockage. It almost contains the effects and indications of present-day *Rou Gui* and *Gui Zhi*, which shows the mixed use of cinnamon-based medicine at that time. The name of *Gui Zhi*, *Rou Gui*, and *Gui Xin* first appeared in *Xin Xiu Ben Cao* of the Tang dynasty, which explicitly states that they refer to the same substance, with *Gui Xin* being the most commonly used term in medicine. It is a "general medicine for all diseases", such as fatigue, difficult labour, abortion, and can also be the antidote for *Shu Jiao* (蜀椒 Zanthoxylum schinifolium, or Zanthoxylum bungeanum) and *Yuan Hua* (芫花 Flos Genkwa) poisoning.[31] The effects of *Gui* in relieving *Yuan Hua* poison can be traced back to Ge Hong's (葛洪) *Zhou Hou Bei Ji Fang* (《肘后备急方》 *Emergency Formulas to Keep up One's Sleeve*) of the Eastern Jin dynasty. As mentioned earlier, since the Song dynasty, the medicinal parts of cinnamon have been differentiated, with the twigs being used as *Gui Zhi*, leading to the corresponding distinction in their therapeutic effects. During the Jin and Yuan dynasties, *Fa Xiang* (法象) pharmacology of TCM emerged and was promoted by Jin-Yuan physicians, such as Li Dongyuan (李东垣) and Zhang Yuansu (张元素). The distinction between therapeutic effects of *Gui Zhi* and *Rou Gui* gradually became clear. Zhang Yuansu, in *Yi Xue Qi Yuan* (《医学启源》 *Medical Origins*), suggested that *Rou Gui* "tonifies the deficiency of fire-heat in the lower *jiao* (补下焦火热不足)", and that *Gui Zhi* is "light and thin, and can dissipate (轻薄而能发散)".[40] Wang Haogu (王好古), in *Tang Ye Ben Cao* (《汤液本草》 *Materia Medica for Decoctions*) further clarified that *Gui Zhi* enters the bladder meridian and *Gui Xin* enters the heart meridian, and that "*Gui Zhi* is used for sweating and *Rou Gui* is used for tonifying the kidneys".[41] According to TCM theory, the medicinal part of *Gui Zhi* shifted to the twigs. They are light in nature and flavor, which promotes an upward and outward dispersing action, making them more effective for disorders of the upper *jiao* or exogenous diseases. In contrast, *Rou Gui* comes from the trunk bark. Its heavy nature and flavor directs a downward action, making it more suitable for tonifying kidney yang deficiency. During the Ming and Qing dynasties, the effects of *Rou Gui* and *Gui Zhi* were further summarized and supplemented. *Ben Cao Meng Quan* (《本草蒙筌》 *Enlightening Primer of Materia Medica*) wrote that *Gui Zhi* has the effect of "treating the head and eyes in the upper *jiao*, and its effect can radiate towards the arms (治上焦头目，兼横行手臂)".[42] The effects of *Gui Zhi* are summarized in *Ben Jing Shu Zheng* (《本经疏证》 *Commentary on the Classic of Materia Medica*), which states that it harmonizes the *Ying* (和营), activates yang (通阳), induces diuresis (利水), descends qi (下气), expels blood stasis (行瘀), and strengthens the spleen and stomach (i.e., middle jiao) (补中).[43]

3.2 Cinnamon in Ayurvedic medicine

In Ayurvedic medicine, the flavor (*rasa* in Sanskrit) of cinnamon (*tvak*) is sweet, pungent and bitter, while its efficacy (*virya*) is hot.[44] The Ayurvedic classic *Caraka*

Samhita (completed in the 2nd or 4th century CE) mentions a paste made of *tvak* for quick relief from the cold.[45] In *Susruta Samhita*, cinnamon bark is included in a group of medicines led by cardamom (*elā*) that are used to expel wind, dispel phlegm, detoxify, eliminate pimples, treat skin conditions such as rashes and rubella, and relieve itching.[46] It is also used in the formulas for removing the placenta, treating leprosy, cleaning the teeth, alleviating coughs, and promoting longevity.[47] *The Bower Manuscript* (4th–6th centuries CE), discovered in Xinjiang, documents the use of cinnamon in formulas such as *Tālīsaka* and *Vardhamānaka* for the treatment of eye diseases, fever, and pain in the heart and abdomen (Fig. 3).[48] Later, the Sanskrit medical text *Siddhasāra* also records the use of cinnamon cinnamon for addressing vomiting and head ailments, as well as its inclusion in an antidote for all poisons.[49] According to *The Ayurvedic Pharmacopoeia of India*, cinnamon bark (*tvak*) treats hemorrhoids, heart/brain disease, disease caused by worms, thirst, dryness of the head and face, head and neck disorders, colds, and bladder disorders.[42]

3.3 Cinnamon in ancient Greek medicine

Cinnamon, cardamom, and saffron were medicines often used by ancient Greek physicians.[50] According to *Ikhtiyarat Badiei (Badi Selections)* by Haji Zain al Din Ansari (1329–1404 CE), a 14th-century Persian physician, Hippocrates noted that cinnamon could energize a person for life. Aly Mazahéri believes that Hippocrates, who died centuries before the emergence of the Silk Road, could not have known about cinnamon. This text shows that the Byzantines and Arabs installed knowledge that was imported later onto the heads of the ancients.[12]

The Greek physician and pharmacologist Pedanius Dioscorides (c. 40–90 CE) was regarded "the father of pharmacognosy". His book *De Materia Medica* was widely read for 1500 years and its insights continue to be passed on today.[51] In book I, it divides cinnamon and cassia into two items and gives a detailed account, but the properties and effects of them are quite similar. It says, "All cinnamons have warming, diuretic, emollient, and digestive properties".[52] They are used to remove birthmarks and freckles, draw down the menses and fetuses, and are useful for coughs, head colds, edema, kidney diseases, and dysuria. They also serve as eye medicine, and antidotes for viper venom and other poisons.

Galen (129–216 CE), the prominent Greek physician, who had a dominant influence on medical theory and practice in Europe until the middle of the 17th century, used cinnamon as one of the basic ingredients of his theriac.[53] The theriac was taken daily by the Emperor Marcus Aurelius to protect against poisons and help to maintain good health.[54]

3.4 Cinnamon in Persian and Arab worlds

Western Asian medicine was largely influenced by Greek medicine. Prescriptions from the Sassanid Empire of Persia, preserved in Islamic medical texts, show that the Jundishapur school (flourishing in the 4th-9th centuries CE) included Chinese cinnamon in tablets for treating cobra bites.[12]

The Persian physician Rhazes (865–925 CE), regarded as the father of Islamic medicine, recorded in his treatise *Kitāb al-Hāwī* (*The Comprehensive Book*) that cassia treats bladder stones, epilepsy, and heart palpitations, and also tightens the vagina. He noted Arabian cassia is "hot moist", and that "It is good to (treat) gastric flaccidity, and it fattens".[55] Cinnamon, according to Rhazes, aids in childbirth, treats hiccups and nausea, and strengthens the heart and stomach. In another work, he asserts that the best type is Chinese cinnamon.[26]

The most important Persian book on pharmacology is *Kitāb-ulabniyat 'an haqā'iq-uladviyat* (*The Book of Remedies Based on the Realities of Medicines*), compiled by Abū Mansūr Muwaffaq Harawī around 970 CE for the Samanid prince Mansur I (Fig. 4). It briefly discusses the indications and dosage of cinnamon (*salīcha*). It says, "It is hot and dry in the third degree, increases the eyesight and dries the organs. Cassia has a slightly astringent effect, distributes and reduces fluids. It strengthens the organs, helps with stomach and liver weakness caused by cold, eliminates urinary urgency and is useful for viper bites".[56]

Another Persian scholar, al-Akhawayni Bukhari (Joveini, ?–983 CE), in his only surviving medical treatise *Hidayat al-Mutallemin Fi al-Tibb* (*A Scholar's Guide to Medicine*), states that Chinese cinnamon is used to treat epileptics: "The Chinese cinnamon and caraway should be added to his diet, lamb should be used as his meat".[26]

Ibn Sina (Avicenna, 980–1037 CE) identified four kinds of cinnamon in *al-Qānūn fī'i-Ṭibb* (*The Canon*

Figure 3 A leaf of *The Bower Manuscript* (source with permission from: https://www.wikiwand.com/en/Bower_Manuscript)

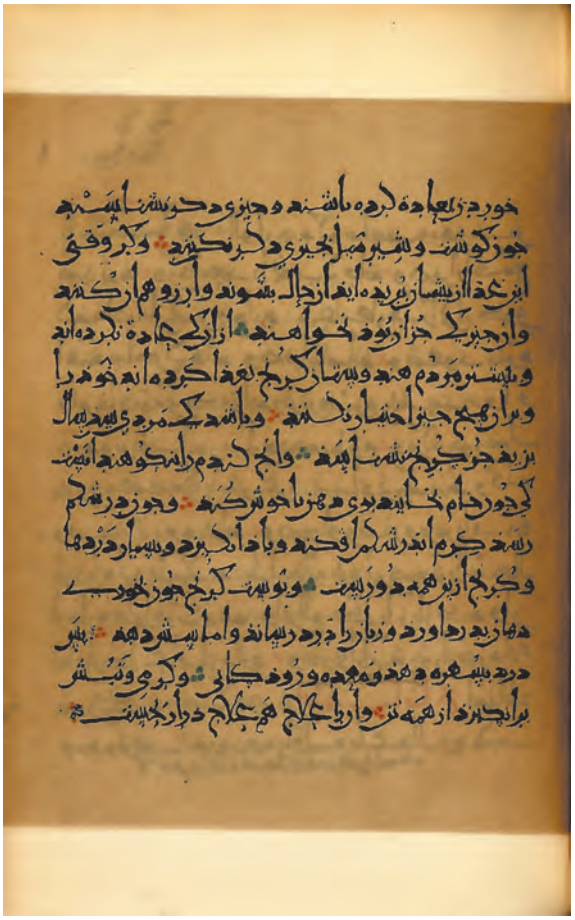

Figure 4 A page of Abū Mansūr's *Kitāb-ulabniyat 'an haqā'iq-uladviyat* transcribed by Asadi Tusi, a famous Persian poet, in the Austrian National Library (source with permission from: *Codex Vindobonensis sive Medici Abu Mansur Muwaffak Bin All Heratensis liber Fundamentorum Pharamacologiae Pars I Prolegomena et textum continens*[57])

of Medicine, volume 2) and highlights its therapeutic effect including treating reddish-black pigmented spots, acne, ulcers, abdominal swellings, head colds, earaches, and blurred or dark vision.[58] Volume 5 of *The Canon of Medicine* contains several medical recipes that use Chinese cinnamon. Avicenna was born near Samarkand, close to the Southern Silk Road through Bukhara, so it's reasonable for him to use medicines imported from China.[59]

Ibn al-Bayṭār (1197–1248 CE), in his *Kitāb al-Jāmi' li-mufradāt al-adwīya wa al-aghdhīya* (*The Book of Medicinal and Nutritional Terms*), compiles references to cinnamon (*dār-chīn*) from previous physicians. It mentions that cinnamon repels wind and cold, makes urine flow properly, dilates obstructions, and treats hoarseness of the throat and generalized edema, and quotes Sufiyānal Andalūsī as stating: "It magically enhances the intellect".[28]

3.5 Commonalities and distinctive features

It can be concluded from the above materials that the applications of cinnamon in various medicine were constantly being enriched and refined. Traditional medicines along the Silk Road commonly use cinnamon to dispel cold, treat respiratory ailments, and alleviate digestive issues. It is also widely regarded for its detoxifying properties and its potential to promote longevity with long-term use. It indicates that cultures are interconnected rather than isolated. Likewise, the effect of cinnamon in treating eye diseases was recognized in ancient Greek and Ayurvedic medicine as early as the 1st-2nd centuries and appeared in Chinese herbal texts since the Tang dynasty, possibly due to the transmission of medicinal knowledge about cinnamon from the West to China.

However, medicine from different regions also have their unique characteristics. The distinctive Chinese philosophical thinking of *Xiang* (象) enables Chinese practitioners to make full use of the cinnamon tree. They believe that different parts have different effects when used in medicine. At the same time, TCM attaches importance to the effect of cinnamon in unblocking the qi, blood and vessels, sinews and bones of the whole body, which is not shared by other medicines. Moreover, it is noticed that Ayurvedic, Greek, Persian, and Arabic medical traditions extensively document the use of cinnamon for treating skin diseases and dental care. In contrast, though TCM documented such uses of cinnamon in medical prescriptions from the Qin and Han dynasties, its later development did not prioritize these applications. This may reflect the traditional focus of Chinese medicine on internal diseases, with comparatively less emphasis on surgical and ophthalmological conditions.

In addition, due to its detoxifying properties, cinnamon serves as a key ingredient in the antidote (e.g. Galen's theriac, *Di Ye Jia* "底野迦" in *Xin Xiu Ben Cao*, "al Tiryāq al-Fārūq" in Avicenna's *The Canon of Medicine*, *Da Er Ya Ji* "答儿牙吉" in *Hui Hui Yao Fang*《回回药方》 *Medicinal Formulas of the Hui People*). Theriac has circulated across various regions of the Eurasian continent for almost two millennia, exemplifying the long-standing exchange between Eastern and Western medical traditions before the Age of Sail.[60] West Asia, as a transit point for East-West exchanges, played a pivotal role in this process.

4 Conclusion

Cinnamon, indigenous to the Orient, has been documented in China since the pre-Qin period (before 221 BCE), with historical records and archaeological evidence suggesting that Chinese cinnamon (Cinnamomum cassia) may have been the primary source of cinnamon utilized in ancient Western societies. As a key commodity in East-West trade, Chinese medicines like cinnamon spread westward via the Silk Road, the Maritime Silk Road, and other trade routes. The Silk Road served as a vital network of trade routes connecting ancient China to civilizations across Asia and Europe, establishing the principal terrestrial corridor for cultural and commercial exchange between East and West in antiquity. Functioning as a maritime counterpart to this overland

route, the Maritime Silk Road started at southern port cities such as Guangzhou, creating an aquatic commercial artery that linked China with Southeast Asia, South Asia, and the Arab world. This network facilitated substantial exchanges of luxury goods including silk, spices, and medicinal substances,[61] reaching particular prominence during the Tang (618–907 CE) and Song (960–1279 CE) dynasties. Notably, the spice trade held such significance in ancient Eurasian commerce that it engendered a parallel trade network—the Spice Route—which flourished from the 7th century BCE to the 2nd century CE. It extended from the Mediterranean to Egypt, across northeastern Africa and the Arabian Peninsula to India and beyond, thereby establishing an essential link between the Mediterranean and the spice-producing regions of Southeast Asia.[62] In addition, the Cinnamon Route, named by modern scholars, is believed to date back millennia, when Indonesian rafts transported cinnamon directly through the sea from Indonesia to Madagascar off the coast of Eastern Africa. From there, local traders carried the cinnamon north to the Roman market.[20] These routes connecting East and West made the spread of cinnamon possible.

In the process of cinnamon trade, Persian and Arab merchants made significant contributions. They as mediators acquired cinnamon from the Chinese and supplied it to Greek and Roman elites through Somali ports. Cinnamon and other medicinal products designated as "Chinese" in Arab and Persian historical texts were predominantly authentic Chinese commodities, or at least owed their dissemination to the Chinese. This perspective aligns with the scholarly assertions proposed by Berthold Laufer in *Sino-Iranica*.[6] Much like silk, these Chinese products became tangible symbols of China itself within Persian-Arabic discourses.

The comparison of the medicinal use of cinnamon in ancient medicine reveals the mutual absorption and integration of medical knowledge across different regions alongside the transmission of the medicine itself, also reflects the distinctive characteristics inherent in different traditional medical systems. The westward spread of Chinese medicinal products profoundly shaped the daily lives and medical practices of people along the Silk Road, and also influenced and enriched Persian medicine as well as other traditional medical systems. Herbs like cinnamon, wild ginger (Asarum), rhubarb, galangal (Alpinia officinarum), and Camphorremain integral to clinical practices in Iran to this day. Studying the westward transmission of traditional Chinese medicine helps to promote the global dissemination of its contemporary knowledge.

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Ethical approval

This study does not contain any studies with human or animal subjects performed by any of the authors.

Author contributions

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Conflicts of interest

The authors declare no financial or other conflicts of interest.

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Feature Article

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Medical Interchanges between Ancient China and the Ancient Middle East from 7th to 15th Century

LIANG Qiuyu[1,✉], ZHENG Min[2]

Abstract

The Silk Road witnessed the exchange, integration, and innovation of medicine between ancient China and the ancient Middle East. This article outlines a panoramic historical picture of medical interchanges between ancient China and the ancient Middle East along the Silk Road by multilingual literature research, textual criticism and scientific methods. Through the exchange of medicinal materials, the supplement of prescriptions, the reference of dosage forms, and the absorption of medical concepts, the two major medical systems along the Silk Road have interacted and integrated. Anchored in the political cooperation, sustained by translation network, and promoted by commercial intercourse, this medical dialogue shows the openness and adaptability of traditional medicine. This interchange history provides a historical paradigm for the modernization of traditional medicine, cross-cultural collaboration, and the building of the Silk Road of Health.

Keywords: Ancient China; Ancient Middle East; Medical Interchange; Silk Road

1 Introduction

The Middle East region includes West Asia and Northeast Africa, where Persian, Arabic and Islamic cultures originated and converged. Although located at the eastern and western ends of Asia, China has a long history of interchanges with the Middle East. It is speculated that as early as five to six thousand years ago, there may have been a "Jade Road" centered on Hotan Prefecture, extending to the Central Plain (中原) along the Hexi Corridor or the grasslands of northern China. In different periods, there was also an "Obsidian Route" from Asia Minor to Persia and a "Lapis Lazuli Route" extending from Afghanistan through Persia and the Mesopotamian Basin to the Mediterranean coast.[1] During Cyrus' reign in the 6th century BCE, China and the Persian Empire had direct contact.[2] In the eyes of the Persians, China had outstanding achievements in philosophy and technologies, and the Chinese were highly regarded as smart and as the most important trading partners. The Islamic world also circulates the Hadeeth that "Seek knowledge even if you have to go as far as China". The Silk Road is not only the main channel for trade between the East and the West but also a bridge for cultural and knowledge interchanges.

Both the Chinese and Middle Eastern civilizations (Note 1) have splendid medical cultures, and their historical interchanges provided mutual impetus for their development between the 7th to the 15th century. Traditional Chinese medicine (TCM) is based on the philosophical theory of yin-yang (阴阳) and *Wu Xing* (五行 five elements) and emphasizes observation, listening and smelling, questioning, and pulse examination in diagnosis. In this period, the Islamic medicine is the mainstream of Middle Eastern medicine, which is based on the ancient Persian-Arabic medical culture and integrates the medical knowledge and philosophical thoughts of ancient Greece, ancient India, and its neighboring regions, the diagnosis of which features urine diagnosis, smelling, and pulse taking.[3] Compared with TCM, Islamic medicine has distinct characteristics in the fields of medicine therapy, diet therapy, external treatment, and psychotherapy, and they have many similarities with TCM in terms of treatment thinking and diagnostic methods.[4]

However, due to the loss of historical materials, language barriers, and the multidisciplinary nature of the research methods required, the study of the history of interchanges of traditional medicine in ancient China and the ancient Middle East has just begun. Chinese scholar Song Xian's (宋岘) *Gu Dai Bo Si Yi*

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Xue Yu Zhong Guo (《古代波斯医学与中国》*Ancient Persian Medicine and China*) explored the historical process of the emergence of medieval Persian medicine and its integration into TCM,[5] and Song also conducted a preliminary study of *Hui Hui Yao Fang* (《回回药方》*Medicinal Formulas of the Hui People*) from the perspective of cultural interchanges between China and foreign countries.[6] Iranian-French scholar Aly Mazaheri's (1914–1991) *The Silk Road* (*La Route de la Soie*) introduced the history of cultural interchanges between ancient China and Persia, which explored the spread of TCM in ancient Persia.[7] American scholar Berthold Laufer's (1874–1934) *Sino-Iranica* verified the plant cultural interchanges between China and Iran from the perspectives of botany, sinology, linguistics, and history.[8] American scholar Edward H. Schafer (1913–1991) focused on the Tang dynasty and analyzed foreign civilizations on the Silk Road, among which the influence from the Middle East was particularly prominent.[9] In addition, Chinese scholar Shi Guang (时光) studied, translated and annotated the earliest Persian translation of Chinese medicine in the Middle East, *Tanksūqnāmah* (*The Ilkhanate Treasure Book of Khatay's Sciences and Technologies*), which provided an important reference for the medical interchanges between ancient China and the ancient Middle East.[10] In recent years, with the advancement of the Belt and Road Initiative (BRI), the importance of medical interchanges between ancient China and the ancient Middle East has received more and more attention.[11,12] Some studies have taken the perspective of economic and trade cooperation and knowledge interchanges,[13–15] some have been based on the comparison of medical texts in these two places,[16] and some have focused on the historical research of medical interchanges during the Yuan dynasty.[17–20] These studies have provided references for the medical interchanges between ancient China and the ancient Middle East. Therefore, this article attempts to outline a panoramic overview of the history of medical interchanges between ancient China and the ancient Middle East to reveal the mutual dissemination, integration, and interaction process of the two significant medicines on the Silk Road and to provide references for continuing the friendship in the past and opening a new chapter in the future.

2 Historical background of medical interchanges between ancient China and the ancient Middle East

There have been official records of interchanges between ancient China and the ancient Middle East since the Han dynasty. Zhang Qian's (张骞) mission to the Western Regions opened up the famous Silk Road building upon several "Gemstones trade routes". During the Wei and Jin dynasties, Chinese and Middle Eastern merchants continued to exchange what they had. Persia was committed to maintaining a cooperative relationship with China, as the number of envoys between the two countries increased, the scale of cooperation also expanded.[21] Zoroastrianism was introduced to China, and some Middle Eastern merchants began to settle in China. In the Tang dynasty, China's influence on the Middle East was greatly strengthened, and key technologies such as porcelain making, saltpeter making, papermaking, alchemy, and silk weaving were introduced to the Middle East, and even a Persian commandery (波斯都督府) was established. Tens of thousands of Arabic and Persian merchants lived in cities such as Chang'an (长安) and Guangzhou (广州).[22] In the Song dynasty, maritime trade between China and the Middle East rose again. Middle Eastern merchants entered cities in southeastern China by sea, and their socioeconomic status was further improved compared with the Tang dynasty, and their relationship with the court was also closer.[23] The Mongolian destroyed the separatist forces in Central Asia and the Abbasid dynasty three times, and the interchanges between the Central Plain and West Asia became interchanges within the Yuan dynasty. During Ghazan Khan's reign, the Ilkhanate's post-road was directly connected to China. Both countries had sufficient reserves of translation talents, and frequent interchanges in science, technology, and culture. Many Muslims in the Middle East initiatively settled in China and gradually assimilated into the Chinese nation. In addition, the emperors of the Yuan dynasty attached great importance to medicine, and the medical interchanges between the two places reached a peak. After the establishment of the Ming dynasty, the land Silk Road stagnated, and the Maritime Silk Road was suspended by the increasingly stringent sea ban (海禁). The interchanges between China and the Middle East took a downward turn and gradually came to a halt.[24]

3 Exchange of medicinal materials between ancient China and the ancient Middle East

3.1 Dissemination of Middle Eastern medicinal materials in ancient China

Due to the differences in geographical environment and medicine preparation technology, the medicinal material trade between ancient China and the ancient Middle East was highly complementary. Spices and medicinal materials are light in weight but high in value and are the bulk commodities of the Silk Road trade. Therefore, the exchange of medicines between ancient China and the ancient Middle East preceded the interchange of holistic medicine.

The use of Middle Eastern medicinal materials in Chinese medicine originated in the Han dynasty. Zhang Zhongjing (张仲景) in the Eastern Han dynasty

recorded in *Jin Gui Yao Lue* (《金匮要略》*Essentials from the Golden Cabinet*) that taking *He Li Le San* (诃黎勒散 myrobalan powder) with porridge could warm and strengthen the intestines, astringe and stop diarrhea. *Hou Han Shu Xi Yu Zhuan* (《后汉书·西域传》*History of the Latter Han Dynasty: Treatise on the Western Regions*) recorded the medicinal value of white grass, storax, and pepper.[25] During the Wei and Jin dynasties, various foreign religions, such as Buddhism and Zoroastrianism, were introduced into China along the Silk Road,[26] which boosted the consumption of spices. For example, Zoroastrianism attached great importance to burning incense and offering sacrifices, and five offerings were made a day.[27] At the same time, the elite emphasized refined living. They wore sachets, burned incense, or applied various aromatic medicines to cure diseases, maintain health, beauty, and hair care, and get scented. During the Wei and Jin dynasties, famous foreign aromatics began to be added to local herbs. The prevalence of religion and the popularity of health culture have significantly increased the demand for aromatic medicines,[28] and various spices have also appeared in the tributes from foreign countries to China.[29] Both *Wei Shu Xi Yu Zhuan* (《魏书·西域传》*History of the Wei Dynasty: Treatise on the Western Regions*) and the *Zhou Shu Yi Yu Zhuan* (《周书·异域传》*Book of Zhou: Treatise on Foreign Regions*) recorded aromatic medicines from the Western Regions, most of which were from Persia.

In the Tang dynasty (618–907), foreign merchants, traders, envoys, priests, and immigrants flooded into China and also brought their lifestyle and medicines. *You Yang Za Ji* (《酉阳杂记》*Random Notes from Youyang*) and other naturalis historia recorded the names, sources, and characteristics of foreign medicinal plants, animals, and minerals used by the people at that time, such as frankincense and dill. *Xin Xiu Ben Cao* (《新修本草》*Newly Revised Materia Medica*) and *Ben Cao Shi Yi* (《本草拾遗》*Supplements to Materia Medica*) have also included many foreign medicines. The first unique study of foreign medicines, *Hu Ben Cao* (《胡本草》*Foreign Materia Medica*), describes the origin, color, and odor of foreign medicinal materials and retains the literary genre of naturalis historia, but it has been lost.[30] In addition, some Buddhist dictionaries in the Tang dynasty also include Persian medicines. For example, there is an entry on Long Pepper (Sanskrit: Pippala; Persian: Pipal; Chinese: 荜茇) in *Yi Qie Jing Yin Yi* (《一切经音义》*Pronunciation and Meaning in Complete Buddhist Canon*).[31]

In the late Tang dynasty, medicinal materials from the Middle East and related theories and practices were further integrated with TCM. Li Xun was of Persian descent and settled in Sichuan (四川), China. His family was engaged in the aromatic medicine business. He was not only an active poet but also very interested in Taoist alchemy. His *Hai Yao Ben Cao* [《海药本草》*Materia Medica from the (Southern) Seaboard Area*] directly quoted Taoist literature such as "*Xian Jing* (仙经)", "*Xian Zhuan* (仙传)", "*Xian Fang* (仙方)", and Taoist alchemy terms;[32] when analyzing the properties of medicines, he often mentioned how Chinese Taoists used these medicines.[30] According to Chen Ming's research, most of the medicinal materials recorded in *Hai Yao Ben Cao* were foreign medicines that had been integrated into the mainstream of traditional Chinese medicine, including 17 Persian-related medicines; *Zheng Lei Ben Cao* (《证类本草》*Materia Medica Arranged According to Pattern*) of the Song dynasty included hundreds of medicinal materials from *Hai Yao Ben Cao*.

In the Yuan dynasty, the emperors' emphasis on medicine and the expansion of territory once again promoted the introduction of Middle Eastern medicinal materials into China. In 1288, Xu Guozhen (许国祯) and nearly 30 other famous doctors of the Yuan dynasty completed the *Da Yuan Ben Cao* (《大元本草》*Materia Medica of the Great Yuan Dynasty*) after four years of effort. This book took the longest time to compile among all the official materia medica in history, and its primary purpose was to supplement the medicinal materials from the expanded territory and neighborhood. A few decades later, Zhu Yuan (朱辕), a scholar of *Ji Xian Dian* (集贤殿 Jixian Academy), wanted to expand the materia medica with exotic products and compiled another *Da Yuan Ben Cao*. Although the latter book was dedicated to the Imperial Academy of Medicine, unfortunately, neither of the two was passed down.[33]

Some scholars have verified the medicinal materials from foreign countries based on the records of Li Shizhen's (李时珍) *Ben Cao Gang Mu* (《本草纲目》*The Grand Compendium of Materia Medica*) in the Ming dynasty and found that among the 46 medicines that were clearly from Persia, only 3 medicines: silver ore, saffron and calamine, were introduced between the Song dynasty and the Ming dynasty (960–1644), and the remaining 43 were used by Chinese doctors earlier.[34]

3.2 Dissemination of Chinese medicinal materials in the ancient Middle East

While Middle Eastern medicinal materials were introduced to China in large quantities, Middle Eastern medical practitioners were also studying and using medicinal materials from China.

Ibn al-Baitar (1197–1248) was a famous botanist in the Middle East. In *Collection of Simple Drugs and Foodstuffs* (*Kitāb al-Jāmi li-mufradāt al-adwiya wa'l-aghdhiya*), he described various medicinal materials, which were later recorded into the Greco-Arabic pharmacopeia. According to him, herbs such as *tutie* (zinc oxide), *bish* (aconite 乌头), and *rēwand chīnī* (rhubarb 大黄) originated in China.[35]

Abū Mansūr Muvaffaq bin'Alī alharavī of the Samanid Empire published *The Book of Remedies Based on the Realities of Medicines* (*Kitāb-ulabniyat'an haqā'iq-*

uladviyat) in 970–975, which recorded new medicinal materials from the East.[36] The Samanid Empire was located in central Asia, not far from the Western Regions under the Tang Empire, so these medicinal materials were highly possible came from China.[37] Abū Mansūr clearly pointed out that celandine was produced in Gansu, China, and explained its medicinal properties and its application in clinical ophthalmology; he also mentioned that *māmīrān* (Coptis chinensis 黄连) originated in China and was famous for healing swollen eyes.[38] Bai Juyi (白居易) of the Tang dynasty wrote a poem, "Receiving letter from friend Qian asking my eye problem (得钱舍人书问眼疾)", which also mentioned the fact that coptis root was common in treating eye diseases in China at that time. In addition, Abū Mansūr also mentioned that *rattan* (Sanguis Draconis 血竭) was from China, and it was hot and dry, able to treat chronic diseases and various poisonings, and the pit was edible. Additionally, there were *nisrīn* (Chinese roses 中国玫瑰) used to treat headaches, fever, and inflammation of sores, and the best ginger was produced in China.

Moreover, ancient Middle Eastern scholars such as Tabari (870), Rāzī (925), Majusi (982), Ibn Sīnā (Avicenna, 1037), and Jurjani (1137) all described Chinese medicinal materials in their works. The most commonly mentioned Chinese medicinal materials in Middle Eastern medical books from the 8th to the 13th century were *dar sini* (cinnamon 肉桂, meaning "Chinese herb"), *Aaron* (wild ginger 野姜), *rivand-e sini* (rhubarb 大黄), *basbasa* (nutmeg 肉豆蔻), *ood* (agarwood 沉香), *sandal* (sandalwood 檀香) and China rose (Ibn al Baytār called it "Gul-e Chini"),[24] as well as *ephedra* (Ephedra vulgaris), camphor (Camphora officinalis), pomegranate (Punica granatum), angelica (Angelica sinensis), hemp (Cannabis sativa), calamus (Acorns calamus), castor oil plant (Ricinus communis), etc.[38] There are also many similarities in the clinical application of these medicines in the Chinese and Middle Eastern medical systems.[14]

3.3 Preliminary summary of the exchange of medicinal materials between ancient China and the ancient Middle East

There are more types of medicinal materials imported from the Middle East to China than those imported from China to the Middle East. Merchants brought peaches, apricots, rhubarb, coptis root, ginger, sandalwood, camphor, cinnamon, celandine, China rose, musk, and tea from China to the Middle East. During the same period, many medicinal materials were imported from the Middle East to China,[8,39] and they are still commonly used in traditional Chinese medicine today; furthermore, many plants are both medicinal and edible (Table 1).

Table 1 Common Chinese medicinal materials originating from the Middle East

Classification	Medicinal Materials
Herbal medicine	Asafoetida (阿魏), saffron (藏红花), turmeric root tuber (郁金), curcuma longa (姜黄), nutgrass galingale rhizome (香附), amomum villosum (砂仁), fennel (小茴香), elecampane inula root (青木香), long pepper (荜茇), figwortflower picrorhiza rhizome (胡黄连), natural Indigo (青黛), aloe, nigellae semen (草豉), alfalfa (苜蓿), coriander, sesame
Plant-based medicine	Frankincense (乳香), myrrh (没药), dipterocarpaceae (龙脑香), dragon's blood (血竭), agarwood (沉香), clove (丁香), terminalia (诃子), pepper, storax (苏合香), phoenix dactylifera (椰枣), jasmine, almond, pistachio (阿月浑子), olive, fig, walnut, grape, jackfruit
Animal medicine	Ambergris (龙涎香), rock honey (石蜜)

4 Interchange of prescriptions between ancient China and the Middle East

4.1 Dissemination of Chinese prescriptions in the ancient Middle East

During the Abbasid dynasty, influenced by Chinese alchemy,[40] the Middle East made significant progress in chemistry, forming a knowledge system for identifying medicinal materials, analyzing medicinal properties, and prescribing.[7,41] In the early 9th century, Middle Eastern scholars learned about ammonia, ammonium chloride, ammonium carbonate, sal ammoniac, saltpeter (potassium nitrate), copper, mercury, and sulfur through the Chinese. The caliphs and princes also asked people to make elixirs, and their preparation methods were very similar to those of Ge Hong's (葛洪).[42] Middle Eastern scholars were proficient in various techniques such as distillation, filtration, sublimation, crystallization, and dissolution, and they divided medicines into monomers and synthetic based on the number of elements and natural components. For instance, a synthetic medicine has different characteristics, such as cold, hot, dry, and wet, while a monomer medicine only has one character. They also classified medicines according to their efficacy, such as antipyretics, antidotes, digestants, etc.

Avicenna's *The Canon of Medicine* was a representative work of Middle Eastern medicine. The second volume "Materia Medica" not only quotes ancient Greek medical elements but also quotes materials from the academy of Jundishapur,[43] which had invited Chinese scholars to translate Chinese materia medica and religious literature during the reign of Khosrau I of the Sassanid dynasty (531–579); the fifth volume is "Prescriptions and Pharmacy (Qarabadin)", which contains more than 600 compound medicines created by famous doctors from many places around the world, such as Andromache's *taryaq* (antidote), Erazistrat's eye medicine, Filag's *iyaraj* (laxative), etc., not only herbal but also preparations containing animal or mineral materials and their combinations.[44]

What's more, Avicenna mentioned that *suk* is a secret formula from China, the primary materials of which are *amlaj* (余甘子, Emblica officinalis, Indian gooseberry) and many other herbs originating from the Middle East (Note 2). It is usually used as a liver protector and is also effective for palpitations.

During the Ilkhanate period, Prime Minister Rashīd al-Dīn recruited professionals and translators from all over the country and established a science, technology, culture, and education center in the eastern suburbs of Tabrīz. He attached great importance to science and technology from China, so he organized the translation and compilation of many scientific works from China, including *Tanksūqnāmah*. According to Mitsuaki Endō, the part "Pharmacology" of *Tanksūqnāmah* should be the Persian translation of the only official prescription book of the Yuan dynasty, *Yu Yao Yuan Fang* (《御药院方》*Imperial Pharmacy Prescriptions*). Engraved in 1338, *Yu Yuan Yao Fang* collected more than 1,000 prescriptions made by the imperial medicine institutions of the Song, Jin, and Yuan dynasties.[45] However, the part "Pharmacology" of *Tanksūqnāmah* was lost in China.

4.2 Dissemination of Middle Eastern prescriptions in ancient China

Bei San Tang (悖散汤 Counterflow-ceasing Decoction) was originally a Persian-Syrian prescription. It was introduced to China no later than the beginning of the Tang dynasty and spread among the Chinese people. According to *Qian Ding Lu* (《前定录》*Records of Predestined Fate: Supernatural Stories from Tang China*), Emperor Taizong of Tang (唐太宗) suffered from dysentery, and none of the doctors' treatments proved effective, so he issued an imperial edict to ask for a prescription. Zhang Baozang (张宝藏), the imperial guard in charge of the security of the capital, had suffered from a similar disease and had been cured after taking *Bei San Tang*, a decoction prepared by boiling milk with long pepper, so he offered this decoction and cured Emperor Taizong. Later, this decoction was included in Sun Simiao's (孙思邈) *Qian Jin Yi Fang* (《千金翼方》*Supplement to "Important Formulas Worth a Thousand Gold Pieces"*).

The emergence of pre-made medicines and changes in dosage forms reflect the influence of Middle Eastern medicine on TCM, which was particularly prominent after the Song dynasty. The number of pre-made medicines in *Tai Ping Sheng Hui Fang* (《太平圣惠方》*Formulas from Benevolent Sages Compiled during the Taiping Era*) and *Sheng Ji Zong Lu* (《圣济总录》*Comprehensive Recording of Divine Assistance*) in the Song dynasty reached over 20,000, showing exponential growth. At the same time, the application of aromatic medicines increased significantly compared with medical prescriptions in the Tang dynasty: some pre-made medicines were primitive chemical medicines,[46] and the dosage forms were mainly pills, powders, and soups, followed by ointments, snowy powders, buccal tablets, aromatics, etc. According to statistics, in 1221, prescriptions mainly based on Middle Eastern herbs had already appeared in China. For example, there were 10 such prescriptions in *Tai Ping Hui Min He Ji Ju Fang* (《太平惠民和剂局方》*Beneficial Formulas from the Taiping Imperial Pharmacy*); from 1225 to 1227, the number was increased to 17, and further increased to 28 from 1241 to 1252.[24] Simultaneously, the Middle East exported asphalt glue and borax as ingredients for pre-made medicines to China. In addition, many Arabic prescriptions were also recorded in Chinese medical classics such as *Yin Shan Zheng Yao* (《饮膳正要》*Principles of Correct Diet*), *Rui Zhu Tang Jing Yan Fang* (《瑞竹堂经验方》*Empirical Formulas from the Auspicious Bamboo Hall*), and *Hui Hui Yao Fang*. The emergence of pre-made Chinese medicines, changes in dosage forms, and innovations in pharmaceutical technology were influenced by Middle Eastern medicine.[47]

5 Interchange of medical knowledge between ancient China and the ancient Middle East

5.1 Dissemination of Chinese medical knowledge in the ancient Middle East

During the Tang dynasty, China and the Middle East had close economic, cultural, and medical interchanges. The exchange of medicinal materials gradually evolved into the interchange of diagnostic and treatment techniques. In the middle of the 8th century, in order to popularize medicine, the Xizang king Me Agtsom (Tridé Tsuktsen) and Tri Songdetsen invited doctors from the Central Plain, Tazi (West Asia), India, Nepal, and other places to teach medicine in Xizang and translated the books they brought into Xizang language. They also sent outstanding students to study in various places, which led to the birth of the *Four Tantras* at the end of the 8th century[48] and promoted the direct interchange of medical knowledge between China and the Middle East.

Acupuncture is one of the basic treatment methods of TCM, and it was known to Middle Eastern scholars during the Tang dynasty. Iraqi merchant and traveler Suleyman Sirafi wrote in *The Travels of Suleyman* that the Chinese have medicine, and the most used one is moxibustion.

Completed around 850, *Firdaws al-hikma* (*Paradise of Wisdom*) was a typical encyclopedia integrating with Chinese, Indian, and Greek sciences. It contained rich content in pharmacy and clinical treatment and cited many historical materials of Chinese Buddhism. The works of two Syrian-Persian doctors, Galen and Dioscorides, also quoted the contents of the Chinese Pharmacopoeia.[48] In short, the spread of Chinese medical knowledge and practical techniques to the West before the Tang dynasty was sporadic.

Pulse diagnosis is an essential diagnostic method of both Chinese medicine and Middle Eastern medicine, and they have something in common, which might be the result of long-term interchanges between the two sides. Avicenna's *The Canon of Medicine* is regarded as the culmination of Middle Eastern medicine. Among the 48 pulse conditions recorded in it, 35 are very similar to those recorded in Wang Shuhe's (王叔和) *Mai Jing* (《脉经》*The Pulse Classic*).[49] In terms of language style, in contrast to the use of figurative metaphors to describe pulses in TCM classics, Avicenna rejected metaphorical expressions and even introduced music as a means of analyzing and classifying pulses, reflecting the pursuit of rationality.[50] Therefore, although Avicenna did not explicitly point out the source of the pulse diagnostic methods, it can be speculated that pulse diagnoses in the Middle East have incorporated that of TCM.[51] Rāzī also studied pulse diagnosis, and he had students from China. Unlike the radial artery pulse diagnosis practiced by Avicenna, Rāzī touched *Taiyang* (EX-HN5), and he pointed out the difficulties doctors encountered in learning pulse diagnosis in *Kunnāsh al-Manṣūrī*. By the Ilkhanate period, the Middle Eastern pulse diagnosis that originated in the 10th century had absorbed rich knowledge from Chinese medicine. According to research, the pulse-taking science in the fragment of *Tanksūqnāmah* came from *Mai Jue* (《脉诀》*Verse on Pulse Diagnosis*),[52] which was popular in the Song and Yuan dynasties and collected various pulse diagnosis theories produced before the Song dynasties.[53]

Due to the close relationship between the Yuan dynasty and the Ilkhanate, the interaction between Chinese medicine and Middle Eastern medicine in the Yuan dynasty expanded and deepened. In the early 14th century, Rashīd al-Dīn and his team members translated many famous Chinese medical books, compiled that knowledge into *Tanksūqnāmah*, and brought Chinese pulse diagnosis, meridians, pharmacology, and materia medica to the Middle East.[54] More importantly, this book systematically explains ancient Chinese medical theories such as "three positions and nine pulse-takings (三部九候论)", "yin-yang (阴阳)" and "twelve meridians (十二经水)" for the first time by quoting some passages from works such as *Su Wen* (《素问》*Basic Questions*), *Nan Jing* (《难经》*The Classic of Difficult Issues*), *Zhen Jiu Jia Yi Jing* (《针灸甲乙经》*The Systematic Classic of Acupuncture and Moxibustion*), *Zhu Bing Yuan Hou Lun* (《诸病源候论》 *Treatise on the Origins and Manifestations of Various Diseases*), etc., expounds on the philosophy of TCM, quoting rich illustrations and annotations in the original TCM classics.[18,55] The Persian interpretation of TCM terms in this book is almost entirely accurate, expressive, and reasonable.[56]

The world history compiled by Rashīd al-Dīn, *Jami' al-Tawarikh* (*The Compendium of Chronicles*), records the spread of Chinese medical classics in Arabia and Persia. There are several records, including *Theory and Practice of Chinese Pulse Diagnosis*, *Herbal Medicine We Are Using and Going to Use*, and *Introduction to Chinese Pharmacy in two parts: Pulse Diagnosis and Formulas*. Scholars of the Ilkhanate took great pains to find copies of these previously lost books. They first translated them from Chinese into Persian and then into Arabic. *Jami' al-Tawarikh* also records that Mahmud Ghazan (Ghāzān Khān, 1271–1304) was proficient in multiple languages and multi-ethnic medical knowledge. After he suffered from eye disease, he received various medical treatments, including Chinese moxibustion, which effectively promoted the spread of TCM in the Middle East and the mutual learning between TCM and Middle Eastern medicine.

5.2 Dissemination of Middle Eastern medical knowledge in ancient China

The earliest introduction of Middle Eastern medical theories, diagnostic, and treatment methods to China likely occurred between 865 and 925 when Rāzī lived. In the book *Kitāb al-Fihrist* (*The Fihrist of al-Nadim*), Ibn al-Nadīm, a Baghdad scholar in the 10th century, tells the story of a Chinese student of Rāzī. This student mastered the spoken and written Arabic language in just five months. After studying with Rāzī for a year, and a month before he left for China, he transcribed the core content of *The Sixteen Books*, a summary of Galen's most influential books in Arabic, in a 'shorthand' writing in Rāzī's library.[57]

The emperors of the Yuan dynasty attached great importance to medicine. Medical talents from all over the world were allowed to enter government positions based on their medical expertise, which undoubtedly significantly promoted the spread of Middle Eastern medicine in China. Ngai-Sie (1227–1308), the Director of the royal hospital in Khanbaliq (元大都), came from Syria. He was proficient in multiple languages. In 1246, he joined the Mongolian army and became a doctor for Kublai Khan, Timur, the Mongolian Empress Dowager Sorghaghtani Beki, and other nobles.[58] In 1270, Kublai Khan ordered the establishment of the Western Region Medical Department (西域医药司) in Khanbaliq, Xanadu (元上都) and Mongolia to treat illnesses and injuries for dignitaries. Ngai-Sie was the general of these medical departments and was also in charge of astrology. He also served as an envoy to visit the Middle East. There were 36 Middle Eastern medical books ever preserved in the Khanbaliq court. Therefore, it can be inferred that Ngai-Sie may have communicated with Rashīd al-Dīn and organized a batch of Middle Eastern medical books to be translated into Chinese.[19]

The prescriptions from the Middle East will inevitably led to the introduction of relevant medical concepts because they crystallize medical theories. *Hui Hui Yao Fang*, probably completed in the late Yuan and early Ming dynasties, is an integration of TCM and Middle Eastern medicine. Some passages in the book come from

Avicenna's *The Canon of Medicine*, but most of them were carefully rewritten, so the style of the whole book is more like a compilation of various prescriptions. From a linguistic perspective, the language sources in *Hui Hui Yao Fang* include Persian, Arabic, and possibly some Syriac and Turkic.[19] Among the three existing volumes, there are 517 medicines named in Arabic or Persian, each with a Chinese transliteration,[59] while Persian served as the third official language after Chinese and Mongolian in the Yuan dynasty. The author of *Rui Zhu Tang Jing Yan Fang* was Shatumusu (or Sademishi), a color-eye official in the Yuan dynasty. *Gan Shi Gao* (甘石膏 Calamine ointment) recorded in the book was the experience prescription passed down by the Hui-Hui people Wumar (Sayyid Ajall Shams al-Din Omar).[60]

The dietary therapy of TCM has a long history, and it also absorbed the concept of diet therapy from Middle Eastern medicine in foreign exchanges. *Yin Shan Zheng Yao*, written by Hu Sihui (忽思慧) in the Yuan dynasty, reflects the scientific and cultural interchanges among ethnic groups along the Silk Road. Western scholars note that some content of *Yin Shan Zheng Yao* is similar to Arabic dietary literature, such as *Taqwīm aṣ-Ṣiḥḥa* (*Taccuinum Sanitatis, Almanac of Health*) by Ibn Butlān (1001–1063).[61] However, the recipes in *Yin Shan Zheng Yao* mainly use Middle Eastern cooking techniques and ingredients[62] and clearly incorporate Chinese Taoist thought into the composition.[63,64] It can be seen that the Yuan dynasty was an era of full integration between Chinese and Middle Eastern medicine, and the interchange and mutual learning between the two greatly enriched each other.

6 Conclusion

Medical exchanges between ancient China and the Middle East were a prominent part of the Silk Road civilization exchange, with a long history and far-reaching influence. The exchanges between the two major medical systems in terms of medicines, prescriptions, diagnosis and treatment techniques and theories not only enriched each other's medical practices, but also promoted the integration and development of cross-regional scientific and technological culture. The spices and medicinal materials introduced from the Middle East to China (such as frankincense, myrrh, saffron, etc.) and the medicines exported from China to the Middle East (such as rhubarb, coptis, cinnamon, etc.) have formed a complementary trade, reflecting the differences in geographical environment and medical needs. Chinese doctors actively absorbed foreign medicines and incorporated them into the local pharmaceutical system, demonstrating the openness and adaptability of TCM; while Middle Eastern scholars integrated Chinese medicines into the Greek-Arab medical tradition through literature records and clinical applications.

Middle Eastern medical preparations (such as pills, powders, and pastes) and chemical pharmaceutical technologies (such as alchemy) had a significant impact on the development of Chinese prescriptions after the Song and Yuan dynasties. TCM pulse diagnosis, acupuncture and other diagnostic and treatment technologies were also introduced to the Middle East through translation and clinical practice, and were absorbed and improved by scholars such as Avicenna. The compilation of works such as *Hui Hui Yao Fang* and *Yin Shan Zheng Yao* during the Yuan and Ming dynasties marked the systematic integration of medical knowledge on both sides.

TCM's yin-yang and *Wu Xing* theory, pulse theory and Middle Eastern medicine's four body fluids (humours) theory and rational diagnosis methods achieved in-depth dialogue during the Ilkhanate period (such as the compilation of *Tanksūqnāmah*). The translation of TCM classics by scholars such as Rashīd al-Dīn systematically introduced TCM philosophy into the Persian-Arab medical system for the first time, and China also absorbed Middle Eastern diet therapy and external treatment techniques through institutions such as the Western Regions Medical Bureau.

The medical exchanges between ancient China and the Middle East benefited from political cooperation (such as the bond between the Yuan dynasty and the Ilkhanate), multilingual translation capabilities, and business travel networks. Although the exchanges declined during the Ming and Qing dynasties, historical experience shows that the progress of medical civilization is inseparable from cross-cultural mutual learning. Re-examining this history of exchanges can not only provide a model for the modernization of traditional medicine and international cooperation, but also help build the historical foundation for a community of shared health for humankind.

Despite challenges posed by fragmented historical records and the multidisciplinary nature of research, recent initiatives under the Belt and Road framework have revitalized academic interest in this field. By reconstructing the historical panorama of China and Middle East medical exchanges, this study highlights the dynamic interplay between these two great medical traditions, offering insights for contemporary cross-cultural medical collaboration and the Silk Road of Health. Future research should leverage multilingual textual analysis, archaeological findings, and scientific methods to further unravel the intricacies of these exchanges, bridging past wisdom with future innovation in global medical heritage.

Notes

1. The Middle East has been known as the cradle of multiple civilizations, but during 7th to 15th century CE, all Middle East empires were Islamic, except Byzantine. However, their medicines shared the some root from ancient Graeco-Roman medicine. The term "Middle Eastern medicine" here encompasses the interconnected Persian, Arab, and Graeco-Arabic

medical traditions (7th–15th centuries) that shared theoretical frameworks (e.g., humoral theory) while maintaining regional variations, reflecting current scholarly practice for comparative studies.
2. The term "*suk*" (a transliteration) for medicine/formula may derive from localized variants in Cantonese (e.g., Siyi dialects), Hakka, or minority language influences (e.g., Zhuang/Yao loanwords), though no standardized Chinese dialect currently uses this pronunciation.

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Ethical approval

This study does not contain any studies with human or animal studies performed by any of the authors.

Author contributions

LIANG Qiuyu conducted literature research, designed the overall historiographic framework, synthesized the narrative, drafted the original manuscript, performed the final cross-check of references and reviewed the final manuscript. ZHENG Min checked historical materials, provided historical insights on medieval Arabic medical texts and critically revised the manuscript.

Conflicts of interest

The authors declare no financial or other conflicts of interest.

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Feature Article

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Enhanced Therapeutic Potential of Chinese Herbal Medicine by Homebrewed Monascus Purpureus Fermented Rice Wine

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Abstract

This study examines the historical and medicinal role of alcohol in traditional Chinese medicine (TCM), with particular emphasis on rice wine. After outlining archaeological and textual evidence of alcohol's therapeutic use, the research addresses the underexplored role of rice wine by analyzing homebrewed, herb-infused variants. Using flow injection analysis (FIA) and Fourier-transform infrared spectroscopy (FTIR), the study evaluated antioxidant activity and bioactive compound retention. Results show that naturally fermented, herb-infused rice wines, especially red rice wines fermented with Monascus purpureus, exhibit superior antioxidant properties, suggesting their potential as effective vessels for enhancing the therapeutic benefits of Chinese herbal medicine.

Keywords: Antioxidant activity; Fermentation; Flow injection analysis with electrochemical detection; Fourrier-transform infrared spectroscopy; Homebrewed Chinese medicinal wines; Monascus purpureus

1 Introduction

While the pre-textual evidence on the earliest instances of alcohol in China is well documented, these findings have not been analyzed in the context of its potentially healing properties. Alcohol was not only featured prominently in the early development of Chinese civilization and culture, but it was also associated with the development of one of the world's earliest medical systems. The very generic term denoting alcoholic beverages in the Chinese script appears in the lower portion of the traditional character *Yi* (醫), meaning "medicine". According to the *Shuo Wen Jie Zi* (《说文解字》 *Explaining and Analyzing Characters*) (circa 100 AD), the character *Yi* refers to the "practice of curing illness", with the lower component *You* (酉) symbolizing the alcohol vessel used by physicians to treat diseases. These etymological links highlight a deep cultural association between alcohol and medicine, a connection also reflected in terms like *Jiu Yao* (酒药) for fermentation starters and *Yao Jiu* (药酒) for medicinal wine. This study reassesses these historical traces and examines the role of alcohol in enhancing the health benefits of herbal therapy.

In this context, our study discovered that the incorporation of herbal extracts significantly enhances the antioxidant properties of rice wines, as measured by FIA-ECD and FTIR methods. Homebrewed herbal rice wines, particularly those with post-fermentation herbal additions, exhibited the highest antioxidant activity. Red rice wines enriched with herbs showed the most pronounced increase in antioxidant potential, likely due to the presence of polyphenols from the Monascus purpureus fungus. Furthermore, our findings suggest that compared to commercial and one-year-old wines, homebrewed medicinal wines demonstrated superior antioxidant activity, confirming the potential of homebrewed (non-commercial) Monascus purpureus-fermented rice wine to amplify the efficacy of Chinese herbal medicine.

2 Mapping the current evidence on wine making and medicinal use

2.1 The earliest textual evidence of wine-making technology in China

In China, as well as in many East and Southeast Asian countries, a common element that serves as the foundation for all such alcoholic beverages is a compressed cluster of yeast and fungi, referred to as *Qu* (曲). The

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earliest reference to *Qu* and winemaking can be found in *Shang Shu* (《尚书》*Book of Documents*), dated to approximately 500–100 BC. This text highlights the use of a fermentation starter for producing *Jiu Li* (酒醴), a type of sweet wine. It should be noted that a specific type of ferment starter, a medicated leaven, also known as *Shen Qu* (神曲 Massa Medicata Fermentata), was additionally utilized for medicinal purposes and contained medicinal herbs, such as *Qing Hao* (青蒿 Artemisia annua), *Cang Er* (苍耳 Xanthium sibiricum), *Chi Xiao Dou* (赤小豆 Vigna umbellata), *Xing Ren* (杏仁 Prunus armeniaca), bran and wheat flour.[1] *Shen Qu* can be used for fermentation, but it is currently commonly used as a Chinese medicinal ingredient that aids digestion by alleviating food stagnation. The earliest recorded reference to the preparation of medicated leaven can be found in the text *Yao Xing Ben Cao* (《药性本草》*Compendium of Materia Medica Properties*) from 600 AD, and *Bei Shan Jiu Jing* (《北山酒经》*The North Mountain Wine Classic*) contains up to thirteen recipes for the preparation of medicinal *qu*.[1] In addition, a type of yeast known as *Hong Qu* (红曲) is also utilised, commonly referred to as red yeast or red koji in Japan. The earliest documented account of the process for producing a red ferment starter can be found in *Ju Jia Bi Yong* (《居家必用》*Necessary Knowledge for Family Use*), a text composed during the Yuan dynasty (1271–1368). However, the utilization of red yeast rice or Monascus in Neolithic China can be traced back to significantly earlier periods, as documented by Li, et al.[2] and other sources (Table 1). This evidence corroborates the textual findings presented by Huang,[3] attributing the initial use of red yeast rice to the Han dynasty (177–217 AD). Subsequently, however, references to its use disappeared from historical records for approximately seven centuries, re-emerging during the Tang dynasty (618–907 AD).[3] Red yeast rice was first referenced as a therapeutic agent in *Ben Cao Gang Mu* (《本草纲目》*The Grand Compendium of Materia Medica*).[3] In this seminal work, Li Shizhen (李时珍) describes red yeast rice as beneficial for nourishing the spleen, stomach, and blood.[4] From a biochemical perspective, the red colouration of rice is caused by a specific type of fungus, Monascus purpureus. Red yeast rice or *Hong Qu Jun* (红麴菌) is unique due to its chemical composition, particularly its content of monacolin K, which is identical to lovastatin, a compound widely used in the pharmaceutical industry to decrease elevated cholesterol. Therefore, both substances can produce similar side effects, potentially harming the liver, nervous system, or gastrointestinal tract.

Other fungi commonly used as the basis for Asian alcoholic beverages are primarily from the genera Aspergillus, Rhizopus and Mucor. Specifically, Aspergillus oryzae, known in Japan as koji and in China as *Mi Qu Jun* (米麴菌), and Rhizopus oryzae or *Mi Gen Mei* (米根霉) are widely utilized.[5] Rice that has been inoculated with these fungi serves as the foundation for various rice-based alcoholic beverages across the East and Southeast Asian region, including sake (日本酒), makgeolli (막걸리), and *Mi Jiu* (米酒). These fungi produce enzymes (α-amylase), which are vital for initiating the fermentation process. The enzymatic activity converts complex carbohydrates into fermentable sugars.[6] Yeasts of the Saccharomyces genus are also commonly present in Chinese ferments.[3]

2.2 A brief history of medicinal uses of wine in China

The earliest known type of Chinese medicinal wine is believed to be an alcoholic beverage called *Chang* (鬯), a ritual wine originating from the Shang dynasty. Evidence of its existence was preserved in oracle bones and shell inscriptions. *Chang* was traditionally produced by fermenting black millet (秬 Panicum sp.) with turmeric, *Yu Jin* (郁金 Curcuma longa).[7,8] Flaws[8] also mentions that herbs were added to the mixtures prior to fermentation and subsequently fermented together, allegedly amplifying the medicinal effects of the utilised herbs, a theory whose effectiveness is further discussed in the section "Materials" of this paper.

The earliest documented references to the medicinal use of alcohol appear in Han dynasty texts, including *Huang Di Nei Jing* (《黄帝内经》*The Yellow Emperor's Inner Classic*), *Shen Nong Ben Cao Jing* (《神农本草经》*Shen Nong's Classic of the Materia Medica*), and *Han Shu* (《汉书》*History of the Han Dynasty*). These texts collectively present various herb processing techniques, including their preparation with alcohol, recommendations for the administration of herbal wines, and particularly a statement characterizing wine as the chief of all medicines.[9–11] The earliest specific prescriptions, however, are derived from the Han tomb of Mawangdui (马王堆), situated in Changsha, as documented in the text *Wu Shi Er Bing Fang* (《五十二病方》 *Formulas for Fifty-two Diseases*) which contains seven herbal wine formulas, known in Chinese as *Yao Jiu*.[8]

As for evidence preceding written records, Table 1 below presents data from some of the most important archaeological sites that have significantly contributed to our understanding of the history of brewing alcoholic beverages, particularly in Neolithic China (Refer to Note 1 for relevant archaeological research). For this article, the "pottery type" category has been omitted, and periodization is presented as a numerical range, as the available sources exhibit slight variations.

The site of Jiahu (贾湖), situated in Henan Province (河南省), dating back to approximately 7000 BC, reveals the earliest evidence of alcohol fermentation in China. Excavations have uncovered ceramic vessels containing residues of rice, honey, and tartaric acid—a compound naturally present in grapes or hawthorn fruit *Shan Zha* (山楂 Fructus crataegi). These ingredients were likely fermented by the yeast Saccharomyces cerevisiae, which

Table 1 An extended overview of major Neolithic-era discoveries pertaining to alcoholic ferments

Site	Period	Archaeological Culture/Period Name	Brewing Materials	Saccharification Method
Jiahu (贾湖) Wuyang, Henan	7000–5000 BC	Peiligang	Rice, Honey, Fruits (grape and/or hawthorn fruit)	Unknown
Qiaotou (桥头) Yiwu, Zhejiang		Peiligang/Shangshan/ (Qiaotou)	Rice, Job's tears, Acorn, Tubers	*Qu*
Xiaohuangshan (小黄山) Shengzhou, Zhejiang	7000–5000 BC (7050–6550 BC)	Peiligang/Shangshan/ (Xiaohuangshan)	Rice, Job's tears, Acorn, Lily	*Qu* with Monascus
Peiligang (裴李岗) Xinzheng, Henan	7000–5000 BC	Peiligang	Rice, Fox nut, Millets, Triticeae, Job's tears, Yam	*Qu* with Monascus
Shuiquan (水泉) Jiaxian, Henan		Peiligang/(Shuiqian)	Rice, Fox nut, Millets, Triticeae, Job's tears, Yam	*Qu* with Monascus
Dadiwan (大地湾) Qin'an, Gansu	5800–5400 BC	Dadiwan	Millets, Job's tears, Triticeae, Acorn, Snake gourd root, Ginger, Tubers	Malted broomcorn millet; *Qu* with Rhizopus, Penicillium
Lingkou (岭口) Lintong, Shaanxi	5800–5400 BC (5950–5050 BC)	Baijia-Laoguantai/ Lingkou/Yangshao	Millets, Rice, Job's tears, Triticeae, Snake gourd root, (Fox nut), Ginger, Bean, Tubers	Malted broomcorn millet and Rice
Guantaoyuan (关桃园) Baoji, Shaanxi	5800–5400 BC (5850–4950 BC)	Baijia-Laoguantai Yangshao	Millets, Job's tears, Triticeae, Snake gourd root, Ginger, Bean, Tubers	*Qu* with Aspergillus and Rhizopus
Dongjiabai (东樻柏) Wenshang, Shandong	5300–4100 BC (4650–4350 BC)	Beixin	Rice, Millets, Triticeae, Snake gourd roots, Acorn	*Qu* with Rhizopus; mastication
Banpo (半坡) Xi'an, Shaanxi	5000–3000 BC (4550–3750 BC)	Yangshao	Millets, Job's tears, Triticeae, Snake gourd root, Fox nut	*Qu* with Aspergillus, Rhizopus/Mucor
Jiangzhai (姜寨) Lintong, Shaanxi	5000–3000 BC		Millets, Job's tears, Triticeae, Rice, Snake gourd root, Bean	*Qu* with Aspergillus, Rhizopus/Mucor; malted broomcorn millet
Huizui (灰嘴) Yanshi, Henan			Millets, Job's tears, Rice	Malted broomcorn millet and Rice
Qingtai (青台) Xinyang, Henan			Foxtail millet, Rice, Job's tears, Triticeae, Snake gourd roots, Lotus roots, Legumes, Nuts (acorn), Fruits (jujube/hawthorn), and/or Honey	Unknown
Dingcun (丁村) Mianchi, Henan	5000–3000 BC (4050–3150 BC)		Millets, Job's tears, Triticeae, Rice, Snake gourd root,	Malted broomcorn millet and rice; *Qu* with Aspergillus and Mucor
Mijiaya (米家崖) Xi'an, Shaanxi	5000–3000 BC (4000–2900 BC)		Millets, Job's tears, Triticeae, Snake gourd root, Lily, Yam, Ginger, Tubers	Malted broomcorn millet
Yangguanzhai (杨官寨) Yangling, Shaanxi			Millets, Job's tears, Triticeae, Snake gourd root, Yam, Lily, Tubers	Malted broomcorn millet
Xinjie (新街) Lantian, Shaanxi			Millets, Job's tears, Triticeae, Rice, Snake gourd root, Fox nut, Lily, Tubers	Malted broomcorn millet and Rice
Xipo (西坡) Lingbo, Henan	5000–3000 BC (3300–2900 BC)		Millets, Job's tears, Triticeae, Rice, Yam, Lily, Snake gourd root	*Qu* with Monascus, Rhizopus/Mucor, Aspergillus
Miaozigou (庙子沟) Inner Mongolia	5000–3000 BC		Millets, Triticeae, Rice, Snake gourd root, Lily, Ginger	Malted broomcorn millet, *Qu* with Rhizopus or Mucor
Wangyin (王因) Yanzhou, Shandong	4100–2600 BC (4250–2650 BC)	Dawenkou	Kudzu root, Snake gourd root, Millets, Triticeae, Tubers	*Qu* with Aspergillus
Xixiahou (西夏侯) Qufu, Shandong			Kudzu root, Snake gourd root, Lily, Millets, Triticeae, Tubers	*Qu* with Rhizopus and/or Mucor
Yuchisi (玉池寺) Mengcheng, Anhui	4100–2600 BC (2800–2600 BC)		Rice, Millets, Job's tears, Triticeae, Snake gourd root	*Qu* with Monascus
Liangchengzhen (两城镇) Rizhao, Shandong	2500–2000 BC (2650–1850 BC)	Longshan	Rice, Fruit (grape and/or hawthorn fruit), probably Honey, possibly Barley	Unknown
Pingliangtai (平粮台) Zhoukou, Henan	(2300–2000 BC)		Millets, Triticeae, Snake gourd root, Rice, Job's tears, Acorn, Lily, Water chestnut	*Qu* with Monascus
Shimao (石峁) Yulin, Shaanxi	2000–1800 BC	Longshan/(Shimao)	Millet, Triticeae, Rice, Lily, Snake gourd root, Ginger/Turmeric, Beans	Malted broomcorn millet
Erlitou (二里头) Yanshi, Henan	1900–1500 BC	Longshan/(Erlitou)	Rice, Triticeae, Millet, Job's tears, Snake gourd root	*Qu* with Monascus

naturally thrives on the surfaces of fruits, within the grape skin, or in diluted honey. It is hypothesized that the rice starch was initially processed through mastication before further decomposition by enzymatic action in saliva.[12] The second-earliest material evidence in China originates from the site of Qiaotou (桥头). In this context, it was mainly ingredients such as rice, Job's tears or *Yi Yi Ren* (薏苡仁 Coicis Semen), acorns, and tubers that were used to make alcohol. It was also the first time the use of a fermentation starter with yeasts (*Qu*) was detected. This substantially differentiates the alcohol from Qiaotou from that of Jiahu, both in the ingredients used and the saccharification methods employed.

Subsequently, evidence from the Xiaohuangshan (小黄山) site reveals the earliest instance of what is notably referred to as "red rice beer" brewing in China, facilitated through the use of *Qu* with Monascus purpureus. During this period, rice cultivation was still developing, and it was closely linked to the production of alcoholic beverages, often regarded as a luxury crop. By the Peiligang (裴李岗) period, millet began to be incorporated as an additional ingredient in alcoholic beverage production, likely due to its widespread availability. Finally, the Dadiwan (大地湾) and Lingkou (岭口) sites provide the earliest evidence of the use of malted broomcorn millet in brewing practices. Among Neolithic cultures, the Yangshao culture (仰韶文化) has yielded the most substantial evidence of alcohol production. This is consistent with the fact that the Yangshao culture was the first formally identified archaeological culture in China and that it holds significant importance in the early development of Chinese civilization.[13] Moreover, this aligns with Slingerland's[14] assertion regarding the correlation between alcohol production and consumption and the level of early social development.

Table 2 provides a detailed description of the most common ingredients found in vessels at excavation sites mentioned in Table 1. The lists contain the name of each ingredient (herb), including its Latin and Chinese equivalents. Additionally, the table includes several categories pertinent to traditional Chinese medicine (TCM), such as medicinal properties, meridian affinity, and key characteristics of each ingredient.[1] It can be hypothesized that brewers added these crops or herbs to support fermentation by providing additional sugars in the form of starches to promote bacterial growth, particularly from grains, snake gourd root, and tubers. Ginger may have been included for its antibacterial properties, helping to prevent the growth of harmful bacteria. In this table, however, the potential medicinal properties of the herbs are discussed in greater detail, whereas other articles only address them superficially.

Given the wide range of ingredients, only the most frequently employed ones were selected for further analysis. In terms of common characteristics, these ingredients are predominantly slightly cold or neutral in nature. According to *Xin Xiu Ben Cao* (《新修本草》 *Newly Revised Materia Medica*) (circa 659 AD), alcohol is not only utilized as a medicinal adjunct to enhance the therapeutic efficacy of herbal ingredients but is also characterized by a bitter, sweet, and pungent taste.[15] Its nature is described to be exceptionally hot and inherently toxic, thereby the need for balancing and cooling. The bland or neutral properties of these ingredients are

Table 2 Common herbs in Neolithic wines and their TCM properties

Brewing Materials	Latin Name	Chinese Name	Properties	Meridian Affinity	Efficacy
Millet	Setaria italica	*Su* (粟)	Sweet, warm	Spleen, stomach	Reduces food stagnation and strengthens the spleen and stomach
Rice	Oryza sativa	*Dao* (稻)	Sweet, neutral	Spleen, stomach	Reduces food stagnation and strengthen spleen and stomach
Job's tears	Coix lacryma-jobi	*Yi Yi Ren* (薏苡仁)	Sweet, bland, slightly cold	Lungs, spleen, stomach, kidney	Tonifies the spleen and augments the lungs, leaches out dampness, cools heat
Snake gourd root	Trichosanthes kirilowii	*Tian Hua Fen* (天花粉)	Bitter, slightly sweet, cold	Lung, stomach	Cools heat, generate fluids, resolves toxicity, reduces swelling, invigorates blood
Tubers (yam)	Dioscorea opposita	*Shan Yao* (山药)	Sweet, neutral	Kidney, lungs, spleen	Tonifies the qi and yin of the lungs, spleen and kidneys
	Dioscorea collettii	*Bi Xie* (萆解)	Bitter, neutral	Bladder, liver, stomach	Expels dampness
	Dioscorea septemloba	*Mian Bi Xie* (绵萆解)	Bitter, neutral	Bladder, liver, stomach	Expels dampness
Lily	Lilum lancifolium	*Bai He* (百合)	Sweet, slightly bitter, slightly cold	Heart, lungs	Enriches the lung yin, drains heat from the heart, stops cough, quiets the spirit (mind)
Ginger	Zingiber officinale	*Sheng Jiang* (生姜)	Acrid, slightly warm	Lung, spleen, stomach	Dispersing in nature, benefits the stomach, alleviates nausea, stops coughing, transforms phlegm

often associated with their ability to expel or leach out dampness, a condition that can arise from alcohol consumption, which weakens the spleen. Many of the herbs discussed here enter the spleen and stomach channels, which are directly related to digestion. As a result, these herbs are commonly used to alleviate food stagnation and to strengthen or tonify both the spleen and stomach. Some of the herbs mentioned in the text serve to replenish or generate moistening and nourishing fluids, or they directly affect the lungs, which are closely associated with bodily fluids. This effect again counteracts alcohol's hot nature, which can cause excessive dryness. In this context, some of the herbs are specifically described as having the ability to cool or drain heat and resolve toxicity. Additionally, the use of lily enhances alcohol's ability to calm the mind, while ginger supports its natural dispersing properties. Both alcohol and ginger possess natural dispersing properties, making them particularly useful in addressing the invasion of external pathogens that manifest as fever with chills. Moreover, ginger is commonly utilized to alleviate nausea. This analysis provides a potential reason for utilising such uncommon ingredients from a contemporary perspective.

3 Meta-analysis of current studies on the properties of herbs in rice wines

To map the current state of studies focusing on the properties of Chinese medicinal wines and to determine the potential gap in knowledge, a search for research articles was conducted using the following keywords: medicinal wine", "Chinese medicinal wine", "medicinal liquor", "Chinese medicinal liquor", and "wine-processed". The identified entries were systematically recorded and categorized according to the name of the herb analysed. Certain single herb articles, as well as complex formulas, were excluded from the analysis due to the use of high-percentage alcohol rather than low-concentration fermented rice alcohol in the preparation process.

The subsequent analysis focused on several key categories, including hypotheses defined by the research teams, analytical methods utilised, type of alcohol and herbs used in processing (including mutual interactions), active compounds, their effects, and final results. A gap in the research was identified in the "type of alcohol" category, attributed to a lack of sufficient data or the complete absence of relevant information regarding the nature of the wine used in these experiments.

Common elements were identified across the analysed articles within each category where applicable. Regarding the hypothesis category, the majority of studies focused on verifying the enhanced therapeutic efficacy of wine-processed herbs compared to their crude forms. Additionally, several studies examined the correlation between the herb's pore structure and its role in dissolution enhancement. Other articles aimed to confirm specific analytical methods for further development, validation, and quality control, as well as to distinguish between crude and wine-processed herbs. Regarding analytical methods, ultra-high performance liquid chromatography (UHPLC), or high-performance liquid chromatography (HPLC), was the most commonly employed technique. Additional methods, scanning electron microscopy (SEM), quadrupole time-of-flight mass spectrometry (collision-induced tandem time-of-flight mass spectrometry) (QTOF-MS/CIT-TOF-MS), ultraviolet spectroscopy (UV), near-infrared spectroscopy (NIRS), fourier-transform infrared spectroscopy (FT-IR) and quadrupole ion trap mass spectrometry (QTRAP) (Table 3 summarizes the studies; detailed references appear in Note 2).

Table 3 **Meta-analysis of herb-infused medicinal wines: methods, wine types, and herbal ingredients (with frequencies)**

Analytical Method (frequency of use in studies)	Wine Type (number of times used in studies)	Herbal Ingredient (number of times used in studies)
HPLC (UPLC/UV, UPLC-QTOF-MS, HPLC-DAD-MS) (10)	Rice wine (6)	Crude Radix scutellariae (12)
UHPLC (UHPLC-MS/MS) (3)	Yellow rice wine (3)	Wine-processed Radix scutellariae (2)
SEM (3)	Rice wine (Shaoxing) 10% (2)	Crude Radix coptidis (2)
QTOF-MS (C-IT-TOF-MS) (2)	Rice wine 17% (1)	Fructus ligustri lucidi (1)
UV (2)	Yellow rice wine (dry type) 16% (1)	Rhizoma ligustici (1)
NIRS (1)		
FT-IR (1)		
QTRAP (1)		

A larger number of studies was reviewed (Note 3), however, they were ultimately excluded from the summary below (or the methods employed in them) due to the prevalence of statistical or other, not closely relevant methods. With respect to the materials used, *Huang Qin* (黄芩 Radix Scutellariae) was the most often used herbal ingredient, predominantly imported from China and applied in various processed forms, including crude, wine-processed, and carbonized preparations. The alcohol utilized in the investigated studies was described as commercial Shaoxing wine imported from China, glutinous rice wine, or yellow rice wine. However, in some cases, the specific type of alcohol used was not further disclosed. The alcohol concentration varied between 10% and 20%, though no explicit concentration was reported in several instances. Regarding the interactive processes, crude herbal materials were sprayed with or briefly soaked in rice wine, with an average duration of one to two hours and a maximum reported soaking time of twelve hours. The materials were stir-fried and subsequently subjected

to further analysis. It is evident that the reviewed studies emphasised the stir-frying process, particularly investigating the impact of varying flame intensities and frying durations. It is also important to note that, unlike other analyses that primarily focus on wine-processed herbs, the current analysis emphasizes the fermentation of rice alcohol from the beginning of the process, followed by the maceration of herbs in the resulting beverage. This analysis also employs a multidisciplinary approach to topics that are usually purely analytical.

In our current study, a wide range of analytical methods were initially employed to determine the antioxidant activity or polyphenol content of different types of wine. The methods included the following: DPPH (2,2-diphenyl-1-picrylhydrazyl) assay,[16–19] F-C (Folin-Ciocalteu) method,[19–21] FRAP (Ferric Ion Reducing Antioxidant Power),[17,19] ABTS (2,2′-azinobis(3-ethylbenzothiazoline-6-sulfonic acid) radical cation) assay with TEAC (Trolox equivalent antioxidant capacity),[22,23] ORAC (Oxygen Radical Absorbance Capacity),[24,25] CUPRAC[17,18,26] and FTIR,[27,28] as well as electrochemical methods such as voltammetry[20,29] and HPLC[30] or FIA[21] with electrochemical detection. In the current study, FIA-ECD and FTIR-ATR methods were finally selected for their simplicity, speed, and availability.

4 Experimental framework for evaluating medicinal wine preparations

Based on the meta-analysis of analytical studies concerned with examining the various properties and potential effects of wine-based herbal infusions, it can be suggested that no particular attention was devoted to the type of alcohol utilized in the examined analyses. The samples in our reviewed studies consisted predominantly of commercially manufactured Shaoxing rice wine (绍兴酒) , and there were no further details of the alcohol used. Therefore, the aim of this research is to determine whether different types of wines affect the final product and whether herbs used in fermented alcoholic beverages are more potent than herbs processed as a decoction or herbs macerated in commercial Shaoxing wine. To present more conclusive claims and verify the effect of medicinal wines on the human body, the samples were analysed for the levels of their antioxidant activity, which can be regarded as a parameter indicating a positive effect of the beverage on human health.

4.1 Materials utilized in experimental design: rice wines and herbal infusion interaction

Two types of homebrewed rice wine, white (W) and red (R), were prepared for further observation. The homebrewed rice wine samples were prepared using glutinous rice variety (*O. sativa*, var. glutinosa) and commercially available rice wine starters (the most common type containing the *R. oryzae* fungus is the *Shang Hai Jiu Bing Wan* (上海酒饼丸) which was utilized for our white rice wine samples, and a commercially available Monascus purpureus-inoculated rice from Wing Fung Asian Herbs and Foods Ltd. for our red rice wine samples and water (Fig. 1, Fig. 2).

Figure 1 Wing Fung Asian Herbs and Foods Ltd. Monascus purpureus-inoculated rice (right) and *Shang Hai Jiu Bing Wan* (上海酒饼丸) (left) (source with permission from: photo taken by the authors)

The standardized recipe utilizes the ratio of 50:50:1 (dry rice to water and wine starter). The rice (weighed in the dry state) was boiled until soft and allowed to cool to room temperature to promote bacterial growth. The wine starter was subsequently crushed into a fine powder and combined with cooked rice and water. Then, it was fermented in a stable room temperature environment, depending on the time required by the experiment design. To ensure adequate conditions for promoting the growth of favourable bacteria and to reduce exposure to airborne contaminants, a lid was placed on top of the glass fermentation jars.

The herbs utilized in the experiment (see Table 4 below for a complete list) were selected due to their prevalence in TCM prescriptions and representative character. The prescription known as *Sang Ju Yin* (桑菊饮 Mulberry Leaf and Chrysanthemum Drink) originates from *Wen Bing Tiao Bian* (《温病条辨》*Systematic Differentiation of Warm Diseases*), a Qing dynasty text written by Wu Jutong (吴鞠通) in 1798 (Fig. 3).

It is one of the most influential texts in the *Wen Bing* (温病 warm disease) school of Chinese medicine, building upon and expanding Zhang Zhongjing's (张仲景) *Shang Han Lun* (《伤寒论》 *Discussion of Cold Damage*), which was published during the late Han dynasty.[3] Originally, *Sang Ju Yin* was used for epidemic prevention (预防瘟疫). However, in 1985, the formula reappeared in *Yao Jiu Yan Fang Xuan* (《药酒验方选》 *Selected Empirical Prescriptions of Medicinal Liquors*), where it was introduced as a treatment for the common cold, as documented in *Zhong Hua Yao Jiu Pei Fang Da Quan* (《中华药酒配方大全》 *The Complete Collection of Traditional Chinese Medicinal Liquor Formulas*).[31] Since then, this

Figure 2 In-process fermentation jars containing 30-day red rice wine (left) and 30-day white rice wine (right) (source with permission from: photo taken by the authors)

Figure 3 Key herbal ingredients of *Sang Ju Yin* (桑菊饮) used in the experimental wine samples (source with permission from: photo taken by the authors)

prescription has been widely utilized in modern clinical practice. According to Scheid and Bensky,[32] this prescription belongs to the category of "Formulas that Release Exterior Wind-Heat". It is indicated for the early stage of a warm pathogen disease, characterised primarily by cough, mild fever, nasal congestion, mild thirst, eye irritation, and an aversion to cold with wind. The herbal mixtures were subsequently introduced to selected finished wine samples. Larger herbal samples were previously processed by a food processor to promote the extraction of active substances. See Table 4 below for a complete list of herbs and the ratios in which they were mixed with the wine samples.

Both types of wines were prepared in two replicates that differed in the length of fermentation, 2 weeks (W2, R2) or 4 weeks (W4, R4). A precisely weighed amount of the herbal mixture was added to the wines at the end of fermentation. The herbs were allowed to be macerated for one week. The ethanol content of the wines was measured at the end of fermentation and after extraction of the herbs. Simultaneously, herbal extracts following identical ratios were prepared in water and also allowed to be macerated for one week. For comparison purposes, a commercial Shaoxing rice wine was purchased with an identical quantity of herbs later added. According to literary sources, medicinal wines were also produced by adding herbs before fermentation began.[8] This method was also included to be further explored. The wine with

Table 4 Key herbal ingredients of *Sang Ju Yin* (桑菊饮) used in the experimental wine samples

Chinese Term	Latin Term	Part Utilized	Weight (for 1 L of wine)
Sang Ye (桑叶)	Morus alba	leaf (folium)	30g
Ju Hua (菊花)	Chrysanthemum morifolium	flower (flos)	30g
Lian Qiao (连翘)	Forsythia suspensa	fruit (fructus)	35g
Bo He (薄荷)	Mentha haplocalyx	herba	10g
Jie Geng (桔梗)	Platycodon grandiflorus	root (radix)	20g
Xing Ren (杏仁)	Prunus armeniaca	seed/kernel (semen)	30g
Lu Gen (芦根)	Phragmites communis	rhizome (rhizome)	35g
Gan Cao (甘草)	Glycyrrhiza uralensis	root (radix)	10g

herbs was allowed to ferment for either 1 week (as with the infused herbs only) or 2 weeks (as with the W2 and R2 wines during fermentation). A summary of the samples analysed is given in Table 5. Although only one batch was produced for each wine type, samples were collected at two different fermentation stages, providing additional replication and allowing us to capture the temporal dynamics of fermentation. Although multiple independent fermentation batches were not included, the combination of two fermentation stages and technical replicates ensured sufficient reliability for the exploratory scope of this study.

Table 5 List of experimental rice wine samples and their abbreviations

Sample Abbreviation	Sample Description
W2	White rice wine 2 weeks of fermentation
W4	White rice wine 4 weeks of fermentation
R2	Red rice wine 2 weeks of fermentation
R4	Red rice wine 4 weeks of fermentation
W2+H	W2 with herbs added after fermentation
W4+H	W4 with herbs added after fermentation
R2+H	R2 with herbs added after fermentation
R4+H	R4 with herbs added after fermentation
Com	Commercial Shaoxing rice wine
Com+H	Commercial Shaoxing rice wine with herbs
R1year	1-year-old medicinal wine prepared identically to R4+H
WFH1	White rice wine fermented with herbs for 1 week
WFH2	White rice wine fermented with herbs for 2 weeks
RFH1	Red rice wine fermented with herbs for 1 week
RFH2	Red rice wine fermented with herbs for 2 weeks
HE100	Herbal extract at 100°C
HErt	Herbal extract at room temperature

4.2 Methods employed for the analysis of rice wine/herbal infusion samples

The samples were analysed for antioxidant activity employing two analytical methods. Firstly, the flow injection analysis (FIA) was performed on an Ultimate 3000 HPLC system (Thermo Scientific Dionex, Massachusetts, USA) with a dual-electrode electrochemical detection (ECD 3000RS equipped with a 6011 RS coulometric cell with a microporous graphite working electrode and a hydrogen-palladium reference electrode). Voltages of 800 and 900 mV were applied to the first and second channels, respectively. The flow rate was set to 1 mL·min^{-1}. Prior to the analysis, samples were diluted 20 times, filtered through a syringe microfilter (45 µm) and injected by overfilling a 20 µL injection loop. The peak areas of both electrochemical channels were integrated, and their sum was used. A signal from 13% ethanol in water was subtracted from the wine signals (except for WFH2 and RFF2 due to its lower ethanol content). All measurements were carried out in triplicate. The antioxidant activity was reported as ascorbic acid equivalents (mmol·L^{-1} AAE). A calibration series was measured in the concentration range of 0.1–5 mmol·L^{-1}.

The second method, a fourier transform infrared (FTIR) spectrometer (Nicolet iS50, Thermo Scientific, USA) with attenuated total reflection (ATR), was used. A drop of undiluted sample (5 µL) was applied to the ATR diamond crystal and pressed with a pressure device. The infrared spectrum in the range of 400 to 4,000 cm^{-1} was measured in 25 scans. The measurements were carried out in triplicate. The antioxidant activity was reported as ascorbic acid and *p*-coumaric acid equivalents (mmol·L^{-1} AAE and CAE, respectively). The calibration series of both acids was measured in the concentration ranges of 50–2,000 mmol·L^{-1} and 31–250 mmol·L^{-1}, respectively. The FTIR results were evaluated using TQ Analyst software (EZ 9.8.208, Thermo Fisher Scientific Inc., USA). Regions with signals present in the spectra of both samples and standards were selected for evaluation, but signals present in the ethanol spectrum were excluded. Two regions have been selected for the AAE (946.9 – 922.8 cm^{-1} and 1183.1 – 1097.8 cm^{-1}), and three regions for the CAE (1431.9 – 1470.5, 1395.3 – 1431.4 and 1363.4 – 1395.3 cm^{-1}). The ethanol content of wines was determined by FTIR-ATR and calibration dependence in the concentration range of 5%–20% ethanol in water.

5 Results

The antioxidant activity of various herbal wines was assessed using three different indicators: FIA-ECD (mmol·L^{-1} AAE), FTIR (mmol·L^{-1} AAE), and FTIR (mmol·L^{-1} CAE). The results are summarized in Table 6.

5.1 Antioxidant activity assessment by FIA-ECD AAE

FIA-ECD AAE values, reflecting antioxidant activity in terms of ascorbic acid concentration, increased considerably in samples containing herbal additives. For example, white rice wine fermented for two weeks (W2) exhibited an AA of 4.33 mmol·L^{-1} AAE, while its herbal-enriched counterpart (W2+H) increased to 19.33 mmol·L^{-1}. A similar trend was observed in red rice wine (R2), where supplementation (R2+H) increased from 6.50 mmol·L^{-1} to 20.70 mmol·L^{-1}. Among the white rice wines, W4 (four-week fermentation) showed a higher AA value (9.05 mmol·L^{-1}) than W2. However, herbal additives remained the dominant factor, as both W2+H and R2+H showed substantial increases compared to their non-herbal controls.

5.2 FTIR-based antioxidant analysis

FTIR AAE values followed a similar pattern. W2+H increased to 385.29 mmol·L^{-1} from 252.44 mmol·L^{-1} in

Table 6 Antioxidant activity and its standard deviation of samples measured by FIA-ECD and FTIR techniques

Sample Abbreviation	Ethanol Content (%)	FIA-ECD (mmol·L^{-1} AAE*)	FTIR (mmol·L^{-1} AAE*)	FTIR (mmol·L^{-1} CAE*)
W2	12.6 ± 0.9	4.3 ± 0.06	252.4 ± 10.1	118.8 ± 28.1
W2+H	11.7 ± 0.2	19.3 ± 0.09	385.3 ± 3.2	142.7 ± 37.9
R2	13.2 ± 0.3	6.5 ± 0.06	162.4 ± 2.5	128.7 ± 35.5
R2+H	12.5 ± 0.1	20.7 ± 0.11	290.9 ± 1.5	145.2 ± 42.2
W4	13.6 ± 0.5	9.0 ± 1.75	116.3 ± 4.9	119.1 ± 34.7
W4+H	12.2 ± 0.1	20.4 ± 0.03	202.3 ± 1.1	133.4 ± 40.4
R4	13.6 ± 0.5	8.1 ± 0.05	138.0 ± 2.0	120.6 ± 35.0
R4+H	12.8 ± 0.5	20.6 ± 0.08	210.3 ± 1.7	140.2 ± 42.7
Com	13.9 ± 0.2	7.0 ± 0.25	143.8 ± 8.0	116.1 ± 29.2
Com+H	13.0 ± 0.4	18.8 ± 0.03	313.8 ± 0.8	148.6 ± 43.0
R1year	13.8 ± 0.3	15.7 ± 0.06	383.4 ± 9.3	154.6 ± 40.1
WFH1	1.9 ± 0.1	4.0 ± 0.04	360.4 ± 2.7	22.4 ± 3.0
WFH2	5.3 ± 0.1	11.0 ± 0.11	417.4 ± 8.9	90.0 ± 24.0
RFH1	2.1 ± 0.1	6.0 ± 0.19	377.6 ± 7.2	43.4 ± 3.2
RFH2	8.4 ± 0.1	9.7 ± 0.37	270.1 ± 0.7	102.7 ± 29.5
HE100	–	13.6 ± 0.03	129.5 ± 6.6	27.4 ± 8.8
HErt	–	14.6 ± 0.09	140.4 ± 1.2	26.4 ± 8.7

*AAE – ascorbic acid equivalents, CAE – *p*-coumaric acid equivalents

W2, while R2+H also showed higher AA compared to R2. FTIR CAE values, representing p-coumaric acid equivalents, also increased in most herbal-enriched samples. The highest levels were recorded for W2+H (142.7 mmol·L^{-1}) and R2+H (145.2 mmol·L^{-1} CAE), compared to their non-herbal counterparts (118.75 mmol·L^{-1} for W2 and 128.74 mmol·L^{-1} for R2).

5.3 Comparison of one-year-old and commercial wines

One-year-old rice wine prepared using the same method as R4+H showed lower AA by FIA-ECD. However, FTIR values (both AAE and CAE) were higher than in freshly prepared herbal wines (e.g., W4+H and R4+H). Commercial wine with added herbs showed a similar trend: lower AA by FIA-ECD but higher values by FTIR compared to fresh herbal wines (R2+H, W2+H, R4+H, W4+H).

5.4 Comparison of red and white rice wines

Red rice wines (R2, R4) consistently exhibited higher baseline antioxidant activity than white rice wines (W2, W4). After herbal supplementation, red rice wines also showed a more pronounced increase in antioxidant activity. Nevertheless, white rice wines supplemented with herbs (e.g., W2+H) still demonstrated significant improvements.

5.5 Fermentation methods: herbs added during vs. after fermentation

Wines fermented with herbs (WFH1, WFH2, RFH1, RFH2) generally exhibited lower AA values (both FIA-ECD and FTIR) compared to wines where herbs were introduced after fermentation (W2+H, R2+H).

6 Discussion and conclusion

The incorporation of herbal extracts significantly enhanced the antioxidant properties of rice wines, consistent with previous findings on the beneficial role of polyphenolic compounds in herbal infusions. These results confirm that herbal extracts contribute to antioxidant potential by increasing phenolic content and free radical scavenging capacity.[33,34]

FTIR analysis further demonstrated that herbal additives enrich wines with specific compounds structurally similar to ascorbic acid or p-coumaric acid.[35–37] FIA-ECD and FTIR measurements provided complementary information: FIA-ECD reflects the total content of oxidizable substances at 0.9 V, while FTIR targets specific vibration bonds of polyphenols and lactone-containing compounds.[38]

Differences observed in one-year-old and commercial wines highlight the influence of processing and storage. Pasteurization, filtration, clarification, and long-term ageing likely degrade or remove antioxidants, reducing the wine's ability to extract and stabilize phenolic compounds from herbs. In contrast, freshly prepared home-brewed herbal wines consistently displayed higher total antioxidant activity.

Red rice wines showed naturally higher antioxidant activity than white rice wines and a more pronounced increase after the addition of herbs. This effect is likely due to the polyphenolic matrix, naturally richer in red

rice wines as a result of Monascus purpureus fermentation, which may facilitate more effective extraction and chemical stability of bioactive compounds in the wine solution during maceration. The higher polyphenol content in red wines thus creates an environment that helps preserve antioxidants released from herbs against degradation. Nevertheless, both red and white rice wines benefited significantly from herbal supplementation.

This study therefore demonstrates that herbal additives substantially enhance the antioxidant activity of rice wines across different analytical methods (FIA-ECD, FTIR AAE, FTIR CAE). Extended fermentation further increased antioxidant activity, although the effect of herbs remained predominant. Comparisons with commercial and aged wines revealed that homebrewed herbal rice wines display the highest antioxidant potential. These findings can promote industry development across functional beverages (incl. low-/dealcoholized), nutraceuticals/cosmeceuticals used as health supplements combating mild respiratory diseases. From a methodological perspective, traceable herb supply chains or FIA-ECD/FTIR-based quality-control services may also benefit from our findings.

The present study foregrounds the potential of homebrewed herbal rice wines as functional beverages, rich in phenolic compounds and free radical scavenging capacity, with promising health benefits for future research and applications. However, any translation to consumer products should prioritize moderation, safety assessment, including potential herb–drug interactions, and transparent labeling and regulatory classification.

Additionally, our review emphasizes the cultural significance of early wine ferments in China, where TCM perspectives provide valuable context for the use of non-traditional ingredients such as tubers and vegetables. Addressing the research gap on medicinal wines, our inclusion of homebrewed rice wine samples provides new insights into their health-related properties.

Notes

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Ethical approval

This study does not contain any studies with human or animal subjects performed by any of the authors.

Author contributions

Kateřina Šamajová designed the research, co-drafted the manuscript, conducted the experiment, carried out partial measurements, co-designed the graphical abstract, polished and edited the manuscript. Pavla Kučerová carried out and supervised the analysis and experiment, conducted the measuring, co-drafted the manuscript and edited the manuscript. Natálie Kubičinová co-drafted the manuscript, carried out the literature review and edited the manuscript. Jaroslav Weinlich contributed to the measurements and analysis.

Conflicts of interest

The authors declare no financial or other conflicts of interest.

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Original Article

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From the Silk Road to the Belt and Road: A History of Chinese-Iranian Medical Exchanges

Ehsan Doostmohammadi[1,✉]

Abstract

Since ancient times, China and Iran, two ancient civilizations with profound medical traditions, have engaged in extensive medical interactions through trade and cultural exchange channels, such as the Silk Road. The paper first reviews the emergence of medical exchanges between the two countries during the Han dynasty, then elaborates on the in-depth development of medical exchanges from the Three Kingdoms to the eve of the Tang dynasty. Entering the Song and Yuan dynasties, the medical exchanges between the two countries became more specific, involving the translation and dissemination of medical classics, the exchanges between doctors, and the trade and cultivation of medicinal materials. The paper further examines the new opportunities and challenges presented by traditional medical exchanges between the two countries under the Belt and Road Initiative. It emphasizes the contribution of this cross-civilization medical exchange to the development of the medical systems of both sides and to human health. This article reveals its far-reaching significance by systematically examining the historical context of medical exchanges between the two countries. It provides historical references and inspiration for future in-depth cooperation between the two countries in traditional medicine.

Keywords: Silk Road; The Belt and Road; Sino-Iranian exchange; Traditional medicine; Avicenna; Chinese medicine; Intercultural history; Global health

1 Introduction

The evolution of medical knowledge is not limited to the independent development of each tradition, but more like a history of mutual learning, absorption, and integration across civilizational boundaries. Among the many far-reaching cross-regional medical interactions, the medical exchange between China and Iran is undoubtedly one of the most historic and rich examples. The history of this exchange can be traced back to the Han dynasty. At that time, the opening of the Silk Road facilitated the circulation of goods and materials, serving as a bridge for the integration of Eastern and Western cultures. The dissemination of medical knowledge was an essential part of it. Since the Han dynasty, medical exchange between China and Iran has undergone the turmoil and integration of the Three Kingdoms, Wei, Jin, Southern and Northern Dynasties, as well as the prosperity and openness of the Tang and Song dynasties. This exchange process is like an endless stream, constantly deepening and expanding its breadth and depth. In the Song and Yuan dynasties, the medical exchange between the two countries reached an unprecedented concrete and comprehensive stage, involving the translation and dissemination of medical classics, mutual visits and exchanges of doctors, and the trade and cultivation of medicinal materials. In recent decades, the Belt and Road Initiative (BRI) has provided a renewed platform for dialogue and cooperation in traditional medicine, making the study of historical Sino-Iranian exchanges more relevant than ever. Despite the wealth of historical anecdotes and textual evidence, a comprehensive academic analysis that traces this interaction across centuries remains limited. This paper aims to fill that gap by providing a historical overview of Sino-Iranian medical exchanges from antiquity to the present day. It draws on classical texts, archaeological findings, and recent policy developments to uncover the evolution and significance of this enduring intercultural relationship.

2 Transmission and mutual records of medical knowledge, from the Jin to the Song dynasties

According to existing archaeological excavations, China has discovered horse bones engraved with ancient Persian cuneiform characters on multiple occasions,

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indicating that the two countries may have had direct contact as early as the 6th century BC.[1] During the reign of Emperor Wu (汉武帝) of the Western Han dynasty, Liu Che (刘彻), at the end of the 2nd century BC, significantly strengthened ties between China and Iran. From the Han dynasty to the Southern Dynasties, China referred to Iran as Anxi (安息), which is derived from the Parthian empire. *Da Yuan Lie Zhuan* (《大宛列传》Biography of Dayuan) in *Shi Ji* (《史记》The *Records of the Grand Historian*) is the earliest chapter in ancient Chinese history that records Parthia.[2] It describes Parthia's geographical location and national conditions.[3] In addition to the literature, many unearthed cultural relics have confirmed that trade between the two countries did exist. For example, the Persian silver box found in the coffin of the owner of the tomb of the King of Nanyue in the Western Han dynasty in Guangzhou in 1983 was considered the earliest "imported product" in Lingnan. These artifacts demonstrate that the Western Han dynasty engaged in maritime trade with Persia in its early years. During the Parthian period, Chinese silk and ironware were exchanged continuously with Persia and Rome. Western jewelry, glassware, incense, ivory, rhinoceros horns, and rare and exotic animals were also introduced to China through Persian merchants and envoys.

2.1 Persian medicines recorded in Chinese literature

With the in-depth exchanges between China and Iran along the Silk Road, the Chinese people's understanding of Persia gradually deepened. Many Chinese historical books from the Jin to the Song dynasties, *Wei Shu* (《魏书》 *History of the Wei Dynasty*), *Sui Shu* (《隋书》*History of the Sui Dynasty*), and *Jiu Tang Shu* (《旧唐书》*Old History of the Tang Dynasty*), medical documents like *Hai Yao Ben Cao* [《海药本草》 *Materia Medica from the (Southern) Seaboard Area*], *Ben Cao Shi Yi* (《本草拾遗》*Supplement to "The Grand Compendium of Materia Medica"*), and *Ben Cao Tu Jing* (《本草图经》*Illustrated Classic of Materia Medica*), local chronicles and notes, and novels like *Zhu Fan Zhi* (《诸蕃志》*Records of Foreign Countries*) and *You Yang Za Zu* (《酉阳杂俎》*Miscellaneous Morsels from Youyang*), record that China imported medicines from Persia. Zhang Hua (张华) of the Jin dynasty recorded in *Bo Wu Zhi* (《博物志》*Records of Natural History*): "Zhang Qian (张骞) of the Han dynasty was on a diplomatic mission to the Western Regions and brought back *An Shi Liu* (安石榴 Punica Granatum) seeds".[4] *An Shi Liu* in Chinese means pomegranate. "An" refers to Anxi, and "Shi" refers to the transliteration of the Persian word for "small grain". *An Shi Liu* refers to a small-grained fruit from the country of Anxi. It is said that Emperor Wu of the Han dynasty planted the pomegranate seeds from Zhang Qian in the Shanglin Garden (上林苑) in Chang'an and the Lishan Hot Spring Palace (骊山温泉宫). *Xi Jing Za Ji* (《西京杂记》*Miscellaneous Records of the Western Capital*) records: "When Emperor Wu of Han first began to expand Shanglin Garden, court officials, remote areas, and neighboring countries all presented precious fruit trees and exotic trees... Ten pomegranate trees were planted".[5] According to *Wei Shu Xi Yu Zhuan* (《魏书·西域传》*History of the Wei Dynasty*: *Biography of the Western Regions*), the medicinal products produced in Persia included a variety of valuable substances such as gold, silver, coral, copper, tin, cinnabar, mercury, silk damask, brocade, styrax, lignum aloes and other aromatic materials, as well as pepper, pipli (long pepper), rock sugar, millennium dates, cyperus, chebulic myrobalan, gallnuts, green vitriol, and orpiment.[6] These Persian specialties feature a diverse range of flavors and medicinal ingredients. At the same time, the Persian medicine resources recorded in *Zhou Shu Yi Yu Zhuan* (《周书·异域传》*Book of Zhou*: *Biography of Foreign Land*) are consistent with the description in *Wei Shu Xi Yu Zhuan*. According to the records of *Sui Shu Xi Yu Si Shi Ba Guo Zhuan* (《隋书·西域四十八国传》*History of the Sui Dynasty*: *Biography of the Forty-eight Western Regions*), China's understanding of Persian medicines during the Sui dynasty was roughly the same as that during the Northern Wei and Northern Zhou dynasties, but at the same time, several new Persian medicines were added, such as *Peng Sha* (硼砂 Borax). Volume 198 of *Jiu Tang Shu* also records that Persia produces a lot of incense and medicine.[7] The author believes that the official history of Persia's abundant incense medicine can prove that the official trade between Persia and the Northern Wei, Northern Zhou, Sui, and Tang dynasties was mainly carried out by exchanging incense medicine for silk. Among the consignments of Persian envoys, there are often "exotic medicines" and "secret and marvelous remedies".[8] Although the Persian state has recorded such medicinal materials in Volume 971 of *Ce Fu Yuan Gui* (《册府元龟》*Prime Tortoise of the Record Bureau*), in most cases, people are unaware of their names. In the fourth year of Emperor Gaozong (唐高宗) of the Tang dynasty (659 AD), Su Jing (苏敬), a crucial Chinese court official, presided over the compilation of a pharmacy masterpiece, *Xin Xiu Ben Cao* (《新修本草》*Newly Revised Materia Medica*). This book systematically organizes knowledge of traditional Chinese pharmacy and innovatively introduces a series of medicines introduced to China from foreign countries, including medicinal materials from Persia. *Xin Xiu Ben Cao* contains 17 types of medicines introduced from Persia to China, including *Lyu Yan* (绿盐 Halite), *Mi Tuo Seng* (蜜陀僧 Mirabilitum), *Shan Hu* (珊瑚 Corallium), *He Li Le* (诃黎勒 Terminalia Chebula), *An Xi Xiang* (安息香 Benzoin), *Mu Xiang* (木香 Radix Aucklandiae).[9] *Xin Xiu Ben Cao* also documents various medicinal substances derived from India, the Indian Ocean, and the South China Ocean islands, which were mainly transported to China by Persian merchants.[9] Chinese doctors have incorporated these

imported aromatic medicines into their medical practice, continually seeking to verify their efficacy. They gradually occupied an essential position in the traditional Chinese medicine (TCM) system and became one of the commonly used TCM varieties. For example, *Ben Cao Jing Ji Zhu* (《本草经集注》*Collective Commentaries on the Classic of Materia Medica*), written by Tao Hongjing (陶弘景), includes a variety of Western Region incense medicines, such as *Chen Xiang* (沉香 Lignum Aquilariae Resinatum), *Xun Xiang* (熏香 Fumigation/Incense), and *Mu Xiang*, which fully demonstrates the recognition and attention of doctors to these foreign medicines. In addition, the world's earliest classic work on TCM diet therapy also provides detailed records of medicines originating from Persia. For example, *Shi Liao Ben Cao Juan Yi* (《食疗本草·卷一》*The Materia Medica for Dietary Therapy: Volume 1*), "*Shi Mi* (石蜜 Rock Sugar), which is produced in Persia, is regarded as particularly fine".[10] Similarly, in the medical book *Wai Tai Mi Yao* (《外台秘要》 *Arcane Essentials from the Imperial Library*), "Persian white rock sugar" is explicitly mentioned to emphasize that the "*Shi Mi*" used in the prescription is a newly introduced foreign medicine.

Documents from the late Tang and Five Dynasties reveal some Persian activities in the region of Shu (蜀). *Song Gao Seng Zhuan* (《宋高僧传》*Biographies of Eminent Monks of the Song Dynasty*) and *Tai Ping Guang Ji* (《太平广记》*Extensive Records of the Taiping Era*) record a doctor named Mu Zhaosi (穆昭嗣), whose ancestral home can be traced back to Persia. Mu Zhaosi was praised for his superb medical skills.[11] In addition, *Shu Gu* (《蜀故》*Ancient Shu*) by Peng Zunsi (彭遵泗) of the Qing dynasty and *Mao Ting Ke Hua* (《茅亭客话》*Record of Visitors at the Thatched Pavilion*) by Huang Xiufu (黄休复) of the Northern Song dynasty mentioned that the Li Xun (李珣) family enjoyed a high status in society during the Former Shu period. Although the medical book written by Li Xun in the late Tang dynasty and the Five Dynasties has been lost, Tang Shenwei (唐慎微), a doctor in the Song dynasty, preserved some of the lost text of the book in *Zheng Lei Ben Cao* (《证类本草》*Materia Medica Arranged According to Pattern*). *Hai Yao Ben Cao* is a monograph on herbal medicine that records foreign medication. Li Xun, a physician of Persian descent, possessed a deep understanding of foreign medicines because his family had been engaged in the trade of spices and medicines for generations. Although some texts in *Hai Yao Ben Cao* are lost, it still records 131 kinds of medicines, of which 96 are marked as having a foreign origin. This book documents over a dozen medicinal substances related to Persia.[12] Some are explicitly named with the term "Persian", such as *Bo Si Fan* (波斯矾 Persian Alum), *Bo Si Wu Yi* (波斯芜荑 Persian Cudweed), and *Bo Si Song Shu Zhi* (波斯松树脂 Persian Pine Resin).[13] Several items originate from Persia, including *Jin Xian Fan* (金线矾 Yellow Alum), *Yin Xie* (银屑 Silver Flakes), *Lyu Yan*, *Hu Tong Lei* (胡桐泪 Resin of Populus euphratica), *Ju Jiang* (蒟酱 Piper retrofractum), *Shi Luo* (莳萝 Dill), *An Xi Xiang*, *Mo Yao* (没药 Myrrh), and *Wu Shi Zi* (无食子 Gallnuts).[13] Certain substances are even accompanied by descriptions of their specific applications in Persia. For instance, in the entry for *He Li Le*, it is recorded that when ships at sea encountered mucus secreted by large sea creatures, rendering the water viscous and impeding navigation, the Persians employed a technique known as the "slime-dissolving method". This involved boiling *He Li Le* in water and using the decoction to wash the ship's hull, eliminating the slickness and allowing the vessel to move freely again. Some scholars believe this method may also have been used on Chinese maritime vessels during the Tang and Song dynasties.[14] There is a record about betel nut in *Hai Yao Ben Cao*, which mentions that "Qin doctors once said that two betel nuts, one raw and one cooked, are crushed into powder and decocted with wine, which has a good effect on treating bladder gas".[15] Some scholars have suggested that the "Qin doctors" mentioned here are an abbreviation of "Nestorian doctors of the Great Qin", referring to those Persian monks who were skilled in medicine.[14]

Additionally, Du Huan (杜环) was a renowned traveler during the Tang dynasty. In 751 AD, he followed Gao Xianzhi (高仙芝) on a military campaign at the Battle of Talas (located in present-day Jambyl, Kazakhstan), where he was captured during the conflict with the Arab Empire. He spent nearly ten years in captivity. Afterwards, he traveled to various countries, including Egypt in Africa, becoming the first Chinese person to visit Africa and leaving written accounts behind. In 762 AD, he returned to China aboard a merchant ship and wrote a book, *Jing Xing Ji* (《经行记》*Record of Travels*). Unfortunately, the original text is no longer available. However, more than 1,500 characters from the work have been preserved through quotations in *Tong Dian* (《通典》*Comprehensive Statutes*), compiled by Du You (杜佑) in 801 AD.[13] The army in which Du Huan served was composed of the Khorasan Army, an elite division carefully selected by the Black Caliphate, and its members were mainly Persian. During his years of military career, Du Huan lived with these Persian soldiers day and night. Therefore, Du Huan's *Jing Xing Ji* contains several herbal medicine names transliterated from Persian, such as Khurma (鹘莽 Date, Persian term for date), Yasamin (耶塞漫 Jasmine Oil), and Choghondar (军达 Beet), referring to beetroot in Persian.[16] These substances were not only utilized as medicinal ingredients, but their phonetic forms in the text demonstrate the influence of the Persian language on Chinese medical nomenclature.[13]

Duan Chengshi (段成式), the son of Tang dynasty prime minister Duan Wenchang (段文昌), collected a large number of stories about the spread of Iranian medicine among the Tang dynasty royal family, dignitaries, and monks. He also established contacts with foreigners

to gain a deep understanding of foreign herbal knowledge. Duan Chengshi's *You Yang Za Zu* provides detailed descriptions of the properties and names of various foreign plants, animals, and mineral medicines, offering rich and accurate content. *You Yang Za Zu* records in detail the medicines produced in Persia, including *An Xi Xiang*, *Ye Se Man*, *Long Xian Xiang* (龙涎香 Ambergris), *Wu Shi Zi*, *A Wei*, *Po Na Sha Shu* (婆那沙树 Ponasha Tree), *Hu Zao* (胡枣 Persian Date).[17]

2.2 Chinese medicines recorded in Persian and Arabic documents

We do not have any Persian or Arabic records about TCM during the Jin dynasty. However, the earliest known reference to TCM appears in the Sasanian text *Khusrau and Rētak*.[18] This work notes that as early as the 6th century, camphor—originating from the Far East—held significant value in the Sasanian Empire. It was utilized in both pharmaceutical preparations and the spice trade. *Zhang Nao* (樟脑 Camphora) was first introduced to the Byzantines by Muslim scholars, and shortly thereafter, to the Western world. The Arabs and Byzantines, in turn, became familiar with camphor through the intermediary of the Persians.[19] According to Persian and Arab writings from the Tang and Song dynasties, Chinese medicines exported to Persia included *She Xiang* (麝香 Moschus), *Rou Gui* (肉桂 Cortex Cinnamomi), *Gui Pi* (桂皮 Cortex Cinnamomi Cassiae), *Da Huang* (大黄 Radix et Rhizoma Rhei), *Tan Xiang* (檀香 Lignum Santali Albi), *Hei Bing Pian* (黑冰片 Myristica fragrans Houtt.), *Fu Zi* (附子 Radix Aconiti Lateralis Praeparata), *Fu Zi Zhou* (附子舟 Aconite Boat), *Xi Su* (西苏 Perilla Frutescens), *Xiong Huang* (雄黄 Realgar),and *Lu Gan Shi* (炉甘石 Calamina). Among them, plant medicines were the main ones, and the only animal medicine was *She Xiang*. Mineral medicines included *Xiong Huang* and *Lu Gan Shi*. At the same time, the Persians had already been using musk during the Sassanid dynasty. Although there is no historical record of when musk was introduced to Persia from abroad, *Jiu Tang Shu* first recorded that the Persians "used *She Xiang* and su to paint their foreheads, ears, and noses as a sign of respect".[20] This is because the exchanges between China and Sassanid Persia developed further during the Tang dynasty. Therefore, the Chinese people's understanding of Persia became more detailed and rich. It cannot be concluded that the Persians did not use *She Xiang* before the Tang dynasty.

Additionally, the second book of *The Canon of Medicine* by Avicenna lists 16 types of medicines imported from China (Fig. 1).[21] Among other works, al-Razi's *Medical Integration*, Hakim Maysari's *Medical Encyclopedia*, and Ali Ibn al-Abbas al-Majusi's *Medical Art Book* also recorded medicines that originated in China.[22] Traditional Iranian medicine has drawn on and absorbed the medicinal properties and practices applied in TCM. For example, *Rou Gui* (Persian, Darchin, meaning "Chinese tree") was described as having a dry and hot temperament; it had the effect of dispelling cold and relieving pain, and was used to treat conditions such as arthritis and stomachache.[21] Avicenna, in the second book of *The Canon of Medicine*, said that *Ou Xi Xin* (欧细辛 Asarum europaeum), which is brought from China, has a hot temperament and the effect of alleviating fever and treating such conditions as the common cold and headaches.[21] Furthermore, the Persian scholar Abū Mansūr Muwaffaq Harawī compiled a pharmacopoeia in Persian around 975 AD, called *Kitab al-Abniya 'an Haqa'iq al-Adwiya (The Book of Remedies Based on the Realities of Medicines)*. The book contains a detailed list of Chinese medicines, including *Rou Gui*, *Fu Ling* (茯苓 Poria), *Huang Lian* (黄连 Rhizoma Coptidis), *Da Huang*, and *Sheng Jiang* (生姜 Rhizoma Zingiberis Recens).[23] The book mentions that *Sheng Jiang* can be divided into three types according to its origin, and ginger produced in China is of the best quality. In addition, the book compares *Da Huang* produced in China and Khorasan, and believes that Chinese *Da Huang* has a wider range of medicinal effects. In addition to *The Book of Remedies*, we can also find detailed records of Chinese medicines in Biruni's Pharmacology. For example, in Pharmacology, the word "Tea" first appeared in Iranian medical literature, and its Persian name was "Cha", not "Chai", which is commonly used in modern Persian.

Figure 1 First folio of Avicenna's *al-Qānūn fī al-Ṭibb* (*The Canon of Medicine*) [source with permission from: National Library and Archives of Iran (NLAI), retrieval no. 24769–5.]

3 Cross-cultural medical exchanges during the Yuan dynasty

During the period of Mongol expansion and the subsequent Yuan dynasty, Genghis Khan and his descendants expanded their empire through westward expeditions, which not only extended political and military influence but also facilitated unprecedented exchanges of culture, trade, medicine, and technology between the East and

the West. This transcontinental network, often referred to as the "Pax Mongolica", provided a stable environment that enabled the large-scale transmission of knowledge, goods, and people across Eurasia.

3.1 Persian physicians in China

During the Yuan dynasty, the Iranians who settled in China became exceptionally well known for their expertise in treating eye diseases. This exotic medical skill was frequently referenced in Yuan-era *Nan Cun Chuo Geng Lu* (《南村辍耕录》 *Random Notes from Nancun*), which mentions a *Yue Qu* (乐曲 song) work called *Huihuiqu*. The name of the song *Ma Hei Mou Dang Dang* (《马黑某当当》) reflects the integration of Iranian culture into Chinese drama.[24] Volume 25 of the same work also catalogs various *zaju* related to Iranian medicine, including *Xiang Yao Che* (《香药车》 *Carriages for Aromatic Medicines*).[24] This title refers to the mobile medicine cart that Iranian herbalists and pharmacists used, which differed from the practices of Chinese people, who typically sold medicine at fixed locations. Indeed, the mobility of Iranian medical practitioners gained them the nickname "traveling doctors".[9]

3.2 Translation and dissemination of Chinese medical classics in Iran

During the Yuan dynasty, Iran also developed a strong interest in China and began to systematically study the Chinese language, medicine, history, and other fields of knowledge. During this period, a distinguished statesman and historian made remarkable contributions to the field—Rashid al-Din Fazl Allah Hamadani (1247–1318). Renowned not only for his political influence but also for his intellectual endeavors, Rashid al-Din produced several works closely related to China. Among his most celebrated writings are *The Book of Precious Chinese Sciences and Technologies under the Ilkhanate*, and *Compendium of Chronicles: History of China*, and *Signs and Living Beings* (Fig. 2). He not only invited Chinese doctors to Iran to exchange medical knowledge but also encouraged local Iranian scholars to learn Chinese, fostering in-depth exchanges and cooperation between China and Iran in fields such as medicine and language.[25] Rashid al-Din came from a medical family and enjoyed a high reputation as a court physician from an early age. Later, due to his exceptional ability in governing the country, he served as prime minister for 19 consecutive years under two dynasties, wielding considerable power. To promote TCM and its texts, he founded the "Rashdi Quadrilateral", a scientific city near Tabriz, the capital of the Ilkhanate. The town boasted a hospital, library, pharmacy, academy, pharmaceutical factory, paper mill, and copying room.[26]

4 Integration of Iranian and Chinese medical traditions in the Ming dynasty

During the Ming dynasty and the Timurid period of Iran, cultural exchanges between China and Iran continued to be frequent. Many Persians traveled to China by land and sea to engage in trade and commerce. Some of these Persians kept detailed records of their experiences in China, providing us with valuable information about cultural exchange and historical data. During the Yongle period of the Ming dynasty, Emperor Zhu Di (朱棣), also known as Chengzu, and Shah Rukh of Persia frequently exchanged envoys. Historical documents from both sides detail these diplomatic exchanges, providing us with a wealth of historical data and valuable diplomatic records. *Ming Shi* (《明史》 *History of the Ming Dynasty*) records nine diplomatic exchanges between the Ming and the Persian dynasties during this period.[27]

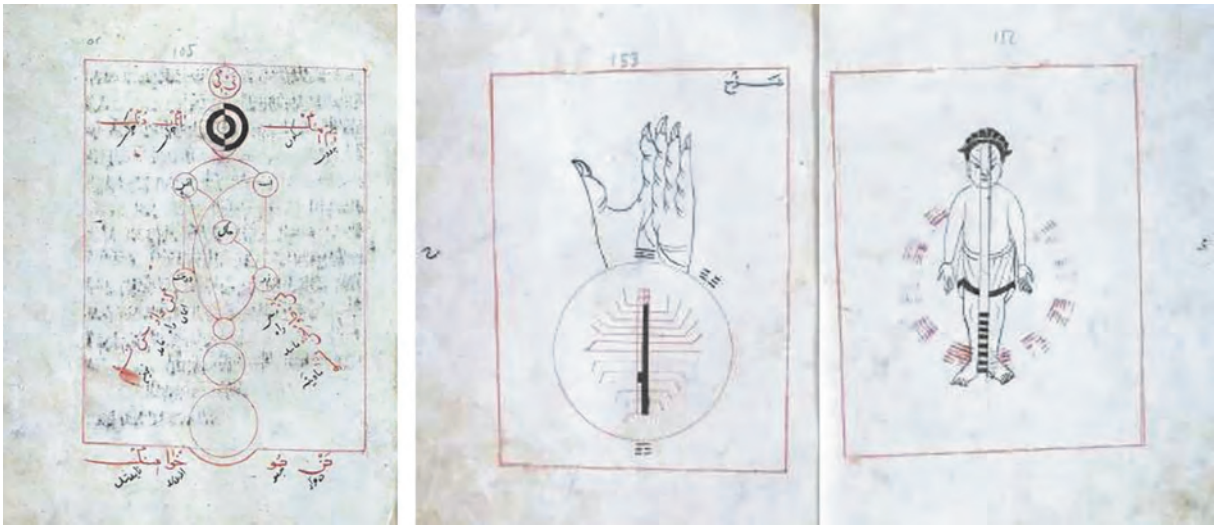

Figure 2 *Tansūqnāma-yi Īlkhān dar funūn-i 'ulūm-i khaṭā'ī* (*The Book of Precious Chinese Sciences and Technologies under the Ilkhanate*) by Rashīd al-Dīn, manuscript leaves (e.g., Aya Sofya 3596, fol. 64b or 65b) (source with permission from: Süleymaniye Manuscript Library, Aya Sofya Collection)

4.1 Introduction of Iranian medical classics into China

The Ming dynasty was a crucial period for the synthesis and development of Chinese Hui medical theories. A key figure during this period was the founding emperor, Ming Taizu Zhu Yuanzhang (明太祖朱元璋), who highly valued and actively incorporated the natural science elements of Hui culture.[14] In the first year of the Hongwu reign, he established a dedicated Huihui astronomical bureau. He summoned fourteen experts, including Hei De'er, the chief eunuch of the Huihui bureau during the Yuan dynasty, to the capital to discuss calendar issues. In September of the fifteenth year of the Hongwu reign, Zhu Yuanzhang ordered Hanlin scholars Li Chong (李翀), Wu Bozong (吴伯宗), and others to translate a Huihui calendar, highly praising the remarkable accuracy of Western yin-yang scholars in predicting celestial phenomena and measuring latitude. The translated work, titled *Tian Shu* (《天书》 *Celestial Writings*), mentioned the extensive collection of Western literature, including Persian, during the early Hongwu reign, covering not only astronomy but also mathematics, engineering, and medicine.

Although there is currently no conclusive historical evidence to confirm whether Zhu Yuanzhang directly ordered the translation of Hui medical texts, his translation of Hui astronomical texts undoubtedly laid a solid foundation for the Chinese translation of Hui medicine and played a positive role in promoting it. Therefore, the compilation of *Hui Hui Yao Fang* (《回回药方》 *Medicinal Formulas of the Hui People*) is likely related to Zhu Yuanzhang's initiatives (Fig. 3). *Hui Hui Yao Fang* is a medical work completed in the late Yuan dynasty. Four fragments are still extant today.[28] It is primarily written in Chinese, with Arabic and Persian names of medicinal substances interspersed throughout. It departs from the traditional Chinese medical theories of yin and yang, the five elements, and organ differentiation, but is deeply influenced by *The Canon of Medicine* of Avicenna. The book offers detailed treatments for paralysis, various internal diseases, and traumatology, with a particular emphasis on distinctive traumatology techniques that contributed to the development of Yuan dynasty bone-setting techniques. The book demonstrates the initial integration of Hui medicine with TCM and shares certain similarities with modern Uyghur medicine. The book not only embodies the characteristics of ethnic medicine but also holds significant medical historical value.

4.2 Persian medicines recorded in TCM books

Compiled over 30 years, *Ben Cao Gang Mu* (《本草纲目》 *The Grand Compendium of Materia Medica*) is a classic medical text by Ming dynasty physician Li Shizhen (李时珍). Comprising 16 sections and containing 1.9 million

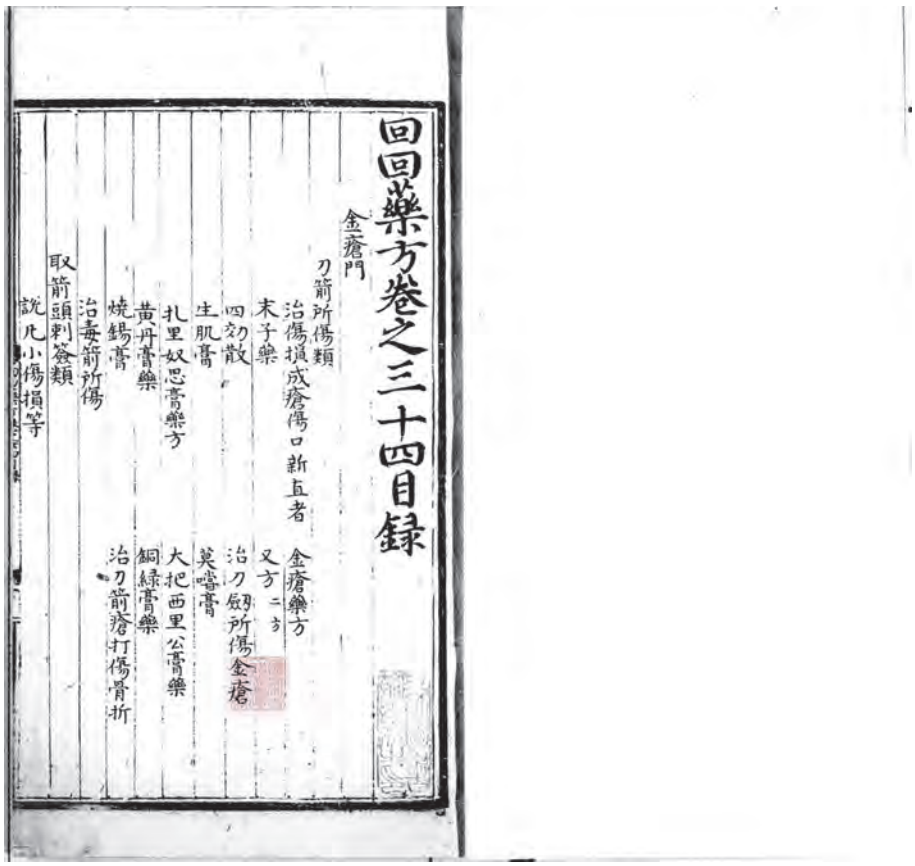
回回藥方卷之三十四目錄
金瘡門
刀箭所傷類
治傷損成瘡傷口新五者 金瘡藥方
末子藥 又方二十
四効散 治刀劒所傷金瘡
生肌膏 奚嗜膏
扎里奴思膏藥方 大把西里公膏藥
黄丹膏藥 銅綠膏藥
燒鍮膏 治刀劒瘡打傷骨折
治毒箭所傷
取箭頭剉瘡類
說凡小傷損等

Figure 3 *Hui Hui Yao Fang*, vol. 34, manuscript leaf (source with permission from: National Library of China)

characters, it catalogs 1,892 medicinal herbs and 11,096 prescriptions, accompanied by 1,109 illustrations.[29] Covering a wide range of subjects, including water, fire, earth, metal, and stone, as well as plants and animals, the work systematically presents the name, background, quality, taste, and indications of each medicinal ingredient. It is a significant work in the field of TCM. In compiling *Ben Cao Gang Mu*, Li Shizhen traveled extensively to various regions and consulted numerous experts to ensure the accuracy and completeness of the information provided. He thoroughly summarized and critiqued previous herbal texts, corrected errors, and proposed a more systematic classification system for medicinal materials in an innovative manner. He constructed a system of classification from low to high, from simple to complex, a highly advanced approach for its time. The first edition of *Ben Cao Gang Mu* was published over 400 years ago. Since then, it has been widely translated into numerous languages, allowing people around the world to benefit from its wisdom. As a World Heritage document, *Ben Cao Gang Mu* was successfully inscribed on the Memory of the World Register in 2011, a testament to its significant value and profound influence.[30] According to statistics, the main volume of *Ben Cao Gang Mu* contains 96 foreign medicinal herbs, 46 of which are of Persian origin.[31] Nearly half of these foreign medicinal herbs are included, comprising nine herbs, twelve woods, seven fruits, fifteen metals and minerals, two vegetables, and one poultry product. This rich variety of foreign medicinal herbs reflects Li Shizhen's extensive knowledge and open-minded perspective. Also, it demonstrates the profound impact of the ancient Silk Road on the exchange of medicines.

Although *Ben Cao Gang Mu* was published 500 years ago, many of the Persian medicinal herbs mentioned in the book dated back much further. In tracing the possible origins, we found that as early as the Qin and Han dynasties (before 220 AD), 11 medicinal herbs had already been introduced into China, including *Wu Yi* (芫荑 Fructus Ulmi Macrocarpae Praeparata), *Zhu Sha* (朱砂 Cinnabar), *Fan Shi* (矾石 Alumen), *Pu Tao* (葡萄 Vitis Vinifera L.), *Xian Shi* (纤石 Fibroferrite), *Lu Hui* (芦荟 Aloe), *He Li Le*, *Bo Cai* (菠菜 Spinacia Oleracea), *Shan Hu*, *Nan Fang Fang Feng* (南方防风 Saposhnikoviae Radix). During the Wei, Jin, and the Southern and Northern Dynasties (220–589 AD), another 12 herbs were recorded as being imported, including *Bing Lang* (槟榔 Semen Arecae), *Lyu Lyu Tong* (绿绿铜 Atacamite), *Wu Bei Zi* (五倍子 Galla Chinensis), *Ru Xiang* (乳香 Olibanum), *Mo Yao* (没药 Myrrh), *Liu Huang* (硫黄 Sulphur), *Ye Se Man*, *Yan* (盐 Salt), *Bi Ba* (荜茇 Piper longum L.), *Wu Mu* (乌木 Diospyros Ebenum), *Chen Xiang* (沉香 Aquilariae Lignum Resinatum), and *Bu Gu Zhi* (补骨脂 Fructus Psoraleae). By the Sui, Tang, and Five Dynasties period (618–907 AD), the number had increased to 20, including *An Xi Xiang*, *A Wei*, *Bing Pian*, *Gan Lan* (橄榄 Oliva), *Shi Luo* (莳萝 Anethum graveolens L.), *Tie* (铁 Ferrum), *Yuan Hua* (元花 Corydalis Yanhusuo), *Hu Huang Lian* (胡黄连 Picrorhiza Rhizome), *Yin* (银 Argentum), *Su Sha Mi* (缩砂密 Fructus Amomi), *Jin* (金 Gold), *Po Luo De* (婆罗得 Baladur), *Lan Dian* (蓝靛 Natural Indigo), *Wu Hua Guo* (无花果 Ficus carica Linn.), *Kai Xin Guo* (开心果 Pistacia Vera L.), *Mi Tuo Seng* (密陀僧 Lithargyrum), *Jue Ming Zi* (决明子 Semen Cassiae), *Bo Luo Mi* (波罗蜜 Jackfruit), *Qian* (铅 Lead), and *Tong* (铜 Copper). From the Song through the Ming dynasties (960–1644 AD), only three new medicinal herbs were introduced. This long trajectory illustrates the enduring history of the Chinese materia medica trade along the Silk Road, which persisted for over a millennium. Such a legacy not only underscores the profound historical depth of TCM but also highlights the Silk Road as a crucial channel for cultural interaction and integration between East and West.

During the same period as the Ming dynasty, Iran was experiencing the rise of the Safavid Empire, and the Iranian people continued to devote themselves to the study of Chinese medicine. Shah Tahmasb Safavid, for example, commissioned a pharmacological treatise that became the first to specifically explore the properties, characteristics, and benefits of Chinese root (Persian: بیخ چینی). The book consists of an introduction and seven chapters, the first of which focuses on the discovery of the Chinese root.[32] The subsequent chapters delve into the properties of the Chinese root, its benefits for the human body, the appropriate conditions for consumption, the flavor variations upon consumption, how to prepare it, and the order in which it should be consumed, and its specific uses. The section on the benefits and characteristics of the Chinese root occupies the majority of the book.

5 Policy and institutionalization of traditional medicine in modern Iran

Before the rise of the Qajar dynasty and throughout the 19th century, direct political relations between Iran and China were not established. This phenomenon was due to several complex factors. First, both countries were mired in internal turmoil and challenges. Iran faced the dilemma of regime change, social unrest, and economic decline, while China also experienced the pressures of dynastic change, border conflicts, and internal reforms. These internal crises and problems directly weakened the willingness and ability of both countries to engage in foreign relations, making it difficult for them to devote sufficient energy to building and developing new political ties on the international stage. These factors not only affected Iran and China at the political level but also inevitably impacted the exchanges and cooperation between the two countries in the medical field.

5.1 Traditional medicine policies in Iran

In 1911, the Iranian government implemented the "New Medical Policy", which marginalized traditional medicine. Only licensed physicians were allowed to practice, medical universities focused on modern medical education, and traditional medicine was confined to folk medicine and herbal medicine shops. After 1955, Iran strengthened its medical regulation and cracked down on illegal medical practices, including traditional Persian medicine. It wasn't until 1977 that the Iranian Ministry of Health officially certified acupuncture certificates for the first time. The Iranian government has long maintained a relatively cautious attitude toward non-Western medical systems, including traditional medicine. This attitude was reflected in historical measures, such as those taken 2,000 years ago, when doctors faced penalties and even legal sanctions for practicing traditional treatments, including bloodletting, cupping, and other methods.[33] However, since 2007, Iran's stance on traditional medicine has shifted in a positive direction. A notable sign was the formal inclusion of traditional medicine in the national medical higher education system for the first time, marking official recognition and educational support for traditional medicine in Iran.

5.2 The path to the legalization of TCM

In 2010, to further promote the development of traditional medicine, the Iranian Ministry of Health and Medical Education promulgated the "*Regulations on the Implementation of Complementary and Alternative Medicine*". This regulation not only recognized the diversity of complementary and alternative medicine, but also subdivided it into more than ten categories, including traditional Indian medicine and TCM. These medical systems were classified as holistic medicine, thus establishing their essential position in the Iranian medical system. This series of measures not only promoted the legalization and standardization of traditional medicine in Iran but also provided a valuable reference for the exchange and cooperation of traditional medicine worldwide.

Since the launch of the BRI in 2013, China and Iran have intensified collaboration in traditional medicine—particularly the promotion of TCM—as part of broader health cooperation.[34] This partnership is underpinned by formal agreements: in 2017, Iran's Minister of Health and Medical Education and China's health authorities (including the National Administration of Traditional Chinese Medicine, NATCM) signed a broad health cooperation agreement alongside a dedicated memorandum of understanding on traditional medicine, which provided for joint education programs, research exchanges, and the establishment of integrated medical centers.[35] Such high-level accords signal strong institutional support from Iran's Ministry of Health and Medical Education and China's NATCM for integrating traditional therapies under the BRI's "Health Silk Road" framework.

To standardize TCM, regulate the diagnostic and treatment practices of TCM clinicians, and improve the scientific nature of decision-making, the Technical Assessment, Standardization, and Health Fee Office and the Clinical Guideline Standardization Office of the Ministry of Health and Medical Education of Iran jointly developed and promulgated 10 clinical guidelines and operational specifications for TCM in 2014: "Moxibustion Therapy", "Dry and Wet Cupping", "Electroacupuncture Therapy", "Acupoint Injection Therapy", "Localized Bloodletting Therapy", "Auricular Therapy", "Gua Sha Therapy", "Acupoint Thread Embedment", "Acupuncture Therapy", and "Tuina Therapy".[36] These clinical guidelines and operational specifications were collectively compiled by renowned Iranian experts and approved by the Iranian National Medical Council.[37] Unified standards and specifications are crucial for the global development of TCM. At the same time, based on the current international development of TCM, in addition to clinical guidelines and operational specifications, other standards are urgently needed, including TCM terminology standards, TCM institution establishment standards, TCM practitioner standards, and TCM medicine and equipment standards. The charging standards for diagnostic and treatment services are approved and promulgated annually by the Cabinet in accordance with the "Relative Value of Health Services". The inclusion of traditional medicine services in the "Relative Value of Health Services" book over the past seven years is one of the valuable achievements of the Iranian Medical Office of the Ministry of Health and Medical Education. The establishment of fee standards for these services is effectively a recognition of traditional medicine by the national health system and a prerequisite for future inclusion in medical insurance. Comprehensive TCM clinics are relatively rare in Iran. Because some TCM and traditional Iranian medical treatments, such as cupping, bloodletting, and herbal remedies, are similar, many patients choose to seek treatment at traditional Iranian medicine clinics. This has led to the majority of TCM clinics choosing acupuncture as their primary service. In 2009, the Imam Reza Public Hospital in Mashhad established Iran's first specialized acupuncture and massage clinic.[38] Currently, there are 44 small public traditional medicine clinics in Iran, most of which provide acupuncture and massage services.[39] According to statistics from the Ministry of Health and Higher Medical Education in 2016, Iran has more than 200 acupuncturists across the country, most of whom work in their own clinics.

6 Conclusion

This study has traced the history of Chinese-Iranian medical exchanges from the ancient Silk Road to the

contemporary BRI. The evidence drawn from Chinese dynastic histories, Persian and Arabic medical texts, and modern trade records demonstrates that medicinal knowledge and materials served not only as commercial commodities but also as vehicles of cultural interaction and intellectual dialogue.

From the Qin and Han dynasties to the Tang and Song periods, Persian and Arabian medicines such as *Zhu Sha*, *Fan Shi*, *Pu Tao*, *Mo Yao*, and *Fan Hong Hua* (番红花 Crocus sativus L.) were introduced into the Chinese pharmacopeia, enriching the foundations of Chinese materia medica. Conversely, Chinese medicinals such as *She Xiang*, *Da Huang*, and *Rou Gui* were incorporated into the medical traditions of Iran and the broader Islamic world. During the Yuan and later periods, works such as Rashid al-Din's treatises further illustrate the mutual exchange of natural and medical knowledge across cultures. These exchanges were not one-sided but were characterized by reciprocity, adaptation, and continuous reinterpretation. The long history of these exchanges highlights three enduring features: continuity spanning over a millennium, complementarity between Chinese and Persian systems of medical knowledge, and cultural hybridity, in which imported remedies were integrated into local epistemologies. Such characteristics underscore the Silk Road as more than normal trade routes, but corridors of intellectual and medical innovation. In the present era, the BRI offers a renewed framework for dialogue and collaboration. TCM continues to find resonance in Iran, while Persian medical heritage provides new comparative perspectives for the study of traditional medicine. Academic exchanges and the integration of complementary medicine into public health systems all point to new possibilities for cooperation. Therefore, the history of Chinese-Iranian medical exchanges is not merely a subject of antiquarian interest but a field with significant contemporary relevance. It demonstrates how medical traditions can travel, transform, and endure, shaping cross-cultural encounters over centuries. In this sense, the legacy of the Silk Road finds new expression in today's Belt and Road, reaffirming the role of medicine as both a cultural bridge and a shared human heritage.

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This study does not contain any studies with human or animal subjects performed by the author.

Author contributions

Ehsan Doostmohammadi participated in the research design, data collection, data analysis, and writing of the paper.

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Original Article

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Traditional Chinese Medicine in Indonesia: History and Contemporary Cooperation

LIU Jiangwei[1,3,✉], Taufik[2], Sity Daud[3]

Abstract

This paper explores the history and contemporary development of traditional Chinese medicine (TCM) in Indonesia, focusing on four dimensions: the early TCM practitioners in Indonesia and their influence, the evolution of TCM education, the regulatory frameworks and management governing TCM practice, and the current TCM cooperation between China and Indonesia. The paper reveals that TCM has gradually become an integral part of Indonesia's healthcare system, thanks to the contributions of early Chinese practitioners. The paper further highlights how the present bilateral cooperation between China-Indonesia concerning TCM has been strengthened under the "Health Silk Road" initiative. It is expected that the two countries will further expand their cooperation on TCM, thus promoting both the internationalization of TCM and broader regional cooperation on TCM.

Keywords: Traditional Chinese medicine; Healthcare; China-Indonesia cooperation; Health Silk Road

1 Introduction

Indonesia, located in Southeast Asia, is the largest archipelago in the world, with more than 10,000 islands, of which about 6,000 are inhabited. As a multi-ethnic, multilingual, and multi-cultural country, Indonesia has a rich cultural heritage and historical traditions, including traditional medicine.[1] For a long time, many native Indonesians, including local government officials influenced by Chinese culture, have embraced traditional Chinese medicine (TCM), recognizing it as an integral part of their own traditional practices and incorporating it into Indonesian traditional medicine.[2] According to historical records, exchanges between China and Indonesia began during the Eastern Han dynasty, nearly 2,000 years ago. In the Five Dynasties and Ten Kingdoms period, due to wars, a large number of Chinese refugees migrated to Indonesia, bringing TCM with them.[1]

In ancient times, exchanges between China and Indonesia were facilitated through the Maritime Silk Road, laying the foundation for bilateral cooperation. Since the launch of the Belt and Road Initiative (BRI), health and well-being have become key focus areas. In June 2016, China's President Xi Jinping (习近平) proposed the "Health Silk Road" in Uzbekistan, highlighting the need for deeper medical and health cooperation, including in infectious disease control, medical aid, and traditional medicine.[3] On January 18th, 2017, President Xi Jinping visited the World Health Organization and signed a health cooperation document under the initiative, marking a milestone in the development of the "Health Silk Road" and offering new perspectives on global public health governance.[4]

Moreover, the Indonesian public has demonstrated a relatively high level of awareness and a positive attitude toward TCM. This recognition has notably increased during the COVID-19 pandemic, leading to growing attention and trust in TCM. Many Indonesians reported being familiar with TCM even before the pandemic and expressed a willingness to recommend it to others, viewing TCM as an effective alternative therapy for certain health issues. China's promotion of the "Health Silk Road" has become a significant concern for China and Indonesia's health cooperation in advancing traditional Chinese medical science, especially in Indonesia.

Consequently, the dissemination and development of TCM in Indonesia play an essential role in its further spread among other countries along the Belt and Road. This article aims to examine the history and development of TCM in Indonesia, including the introduction of TCM, the evolution of Indonesia's policies on TCM, TCM education in Indonesia, and

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the various forms of cooperation between China and Indonesia under the BRI. By studying these aspects, this research helps to deepen the understanding of the current state and future potential of TCM development in Indonesia, providing practical insights for promoting the internationalization of TCM and enhancing bilateral cooperation.

2 History and early practitioners of TCM in Indonesia

Traditional medicine in Indonesia is referred to as "Jamu" and the indigenous people of Indonesia also have their own term for traditional healers, commonly known as "Dukun".[5] In its development, traditional medicine in Indonesia was greatly influenced by foreign cultures, such as India, the Middle East (Arab), Europe, and China.[6] TCM in Indonesia was brought by the migration of ethnic Chinese to the archipelago in the 7th century and further enhanced by the arrival of Admiral Zheng He (郑和) in the 15th century. The migrants also brought practitioners of traditional medicine, known as Tabib (Sinse).[5]

According to Salmon and Sidharta,[7] very little is known regarding TCM in Indonesia and most information can only be found in the records of European travelers and Dutch officials. As early as 1635, the Christian Chinese Master Isaac (original name Equa, nickname Loccon, derived from the Malay word dukun meaning "medicine man") was appointed as a physician for the Dutch East India Company. This indicates that Chinese physicians were already present in Java in the last decades of the Ming dynasty. In 1640, the Chinese community in the Batavia obtained permission to establish a "Chinese Hospital", which was completed in 1646 and known in Chinese as *Yang Ji Yuan* (养济院) which means "Hospice for the Poor" (Fig. 1). The hospital was managed by a committee that included both Dutch and Chinese administrators, including Master Isaac. Subsequently, some pharmacists showed a strong interest in TCM texts. In an 1889 article, Voderman discussed in detail the names and translations of Chinese medicinal herbs. In 1890, Chinese physician Tjoa Tjoe Koan (蔡珠贯) translated a collection of Chinese prescriptions into Malay, titled *Tiok Ik* (《药译》 *Medicine Translation*) and submitted it to the Batavia Society. These early records reflect the gradual development of TCM in Indonesia and its status in Indonesian society. However, as European interest in TCM waned over time, documentation on this subject became increasingly scarce. From the late 1890s to the early 20th century, the rise of Western medicine hindered traditional medicine in China, which in turn affected the spread and development of TCM overseas.[8]

Figure 1 The Chinese hospital at Batavia (HET SINEES SIKEN HUYS), translated by the authors (source with permission from: https://www.atlasofmutualheritage.nl/en/page/3552/the-chinese-hospital-at-batavia)

3 Management and regulations of TCM in Indonesia

During the early decades of the Republic of Indonesia, Chinese doctors continued to practice medicine as they had during the Dutch colonial period. There wasn't any specific law targeting TCM. Doctors did not have to register, and pharmacists were allowed to sell traditional Chinese medication, except for patented medicines that had obtained distribution permits from the Food and Drug Supervisory Agency (Badan Pengawas Obat dan Makanan/BPOM)[9].

Between 1882 and 1890, a pharmacy called *Wan Fu Tang* (万福堂), or "Hall of the Ten Thousand Happinesses", operated in Palembang. In Batavia, in addition to Ji'an Tang, there were also *Fu Sheng Tang* (福生堂), or "Hall of Happiness and Life", *Tong An Tang* (同安堂), or "Hall of Shared Peace", and *Chun Sheng Tang* (春生堂), or "Hall of the Coming Spring". In Semarang, there was *Guang Sheng Tang* (广生堂), or "Hall of the Great Ascendance". From 1899 to 1905, at least six pharmacies were documented in Surabaya: *Chun Lin Tang* (春林堂), or "Hall of the Spring Forest", *Bao Sheng Tang* (保生堂), or "Hall of Life Protection", *Ren An Tang* (仁安堂), or "Hall of Perfect Virtue and Tranquility", *Ren He Tang* (仁和堂), or "Hall of Perfect Virtue and Harmony", *Wan Shou Tang* (万寿堂), or "Hall of Longevity", and *Dun Ren Tang* (敦仁堂), or "Hall of Generosity and Perfect Virtue".[7]

Traditional medicine clinics in Indonesia are becoming increasingly popular as an alternative means for people to obtain health services because traditional medicine generally offers more affordable prices than conventional medicine. Article 28H, paragraph 1, of the 1945 Constitution states, "Everyone has the right to live in physical and spiritual prosperity, to have a place to live, and to have a good and healthy living environment, and to have the right to obtain health services". Since 1974, the Indonesian government has implemented regulatory measures for the traditional medicine industry. That

year, the government issued the "Traditional Medicine Supervision Regulation", which required herbal medicine stores to employ licensed pharmacists to continue operating. In addition, the regulation required traditional medicine practitioners to reapply for permits and pass exams to practice legally. In 1975, the Indonesian Ministry of Health further tightened the regulation of medicine imports, explicitly prohibiting the import of Chinese patented medicines. Nevertheless, herbal medicine importers continued to source products through channels in China and Singapore to meet local market demand. In 1992, the Indonesian National Assembly issued Regulation No. 23, which categorized traditional medicine as a widely accepted form of medical treatment, marking the beginning of greater focus on and encouragement for the development of TCM.[9]

In 2008, the Indonesian Medical Council approved standards for acupuncture education and skills, which advanced the standardization of the acupuncture industry in Indonesia. Meanwhile, traditional health services are regulated by the government through Law No. 36 of 2009 concerning Health, in which Article 1, paragraph 16 states that traditional health refers to treatment and care using methods and medicines that are based on experience and skills that are passed down through generations and can be empirically verified and applied by prevailing norms in society.[10] Law No. 36 of 2009 recognizes TCM as Complementary Traditional Health Services that can complement conventional medicine, considering its safety, quality, and the efficacy. Therefore, every traditional health practitioner must have an official certification of expertise. Regulation of the Minister of Health No. 61 of 2016 on Traditional Health Services emphasizes that practitioners (Sinse/Tabib) of TCM must have a registered license or meet the service standards. Meanwhile, a license or practice permit must be submitted to the Regional Health Office to ensure that they can provide safe traditional services in accordance with government standards (Fig. 2).

In 2017, the Indonesian Ministry of Health simplified registration requirements for traditional medicine practitioners, allowing both domestic and international practitioners to register. In addition, the government recognized the roles of the Indonesian Acupuncture Association and the Traditional Chinese Medicine Association in formulating health policies. Foreigners were allowed to open traditional medicine clinics and herbal medicine shops in Indonesia. Figure 3 illustrates the timeline of TCM history in Indonesia from its introduction to the point when practitioners were first allowed to register for conducting TCM treatment (Fig. 3). In 2018, the Minister of Health issued Regulation No. 15 on implementing Complementary Traditional Health Services, which regulates traditional medicine therapies such as herbs and acupuncture. It also regulates how traditional medicine can be integrated with modern medicine.[11]

Figure 2 TCM Treatment Center at Bengkulu [Pusat pengobatan tradisional China (TCM) yang membuka praktek di Bengkulu], translated by the authors (Source with permission from: https://bengkuluekspress.disway.id/read/13578/sin-she-kembali-hadir)

In 2022, Indonesia's Food and Drug Authority (BPOM) issued new import regulations, setting precise regulatory requirements for importing food, cosmetics, health supplements, medicines, and traditional medicines. In 2023, Indonesia introduced a draft halal certification for pharmaceuticals, biologicals, and medical devices, requiring all products entering or traded in Indonesia to obtain halal certification issued by the Ministry of Religious Affairs' halal certification agency. This regulation also establishes stricter market entry standards for medical products. Through these policies and regulations, the Indonesian government is progressively strengthening its oversight of the traditional medicine industry while promoting standardization and healthy development.[12]

It is worth mentioning that the development of TCM in Malaysia shares many similarities with Indonesia's, both being closely linked to Zheng He's voyages to the West Ocean and widely disseminated by Chinese immigrants before taking root locally and gradually gaining recognition. However, differences exist between the two countries in TCM management systems and regulations (Table 1).

4 TCM education in Indonesia

In Indonesia, there are basically two models of TCM education: apprenticeship-based training and institutional education. In the early days, roughly before the 1970s, Indonesia had no TCM education institutions. TCM practitioners were mainly trained through "father-to-son transmission" or "private apprenticeship".[13]

In the early stages of TCM development in Indonesia, the Overseas Education College of Xiamen University (厦门大学) played a crucial role. In 1956, Xiamen University established the Overseas Chinese Correspondence Department, offering courses in TCM and Chinese language. The department targeted overseas Chinese, providing correspondence education for those

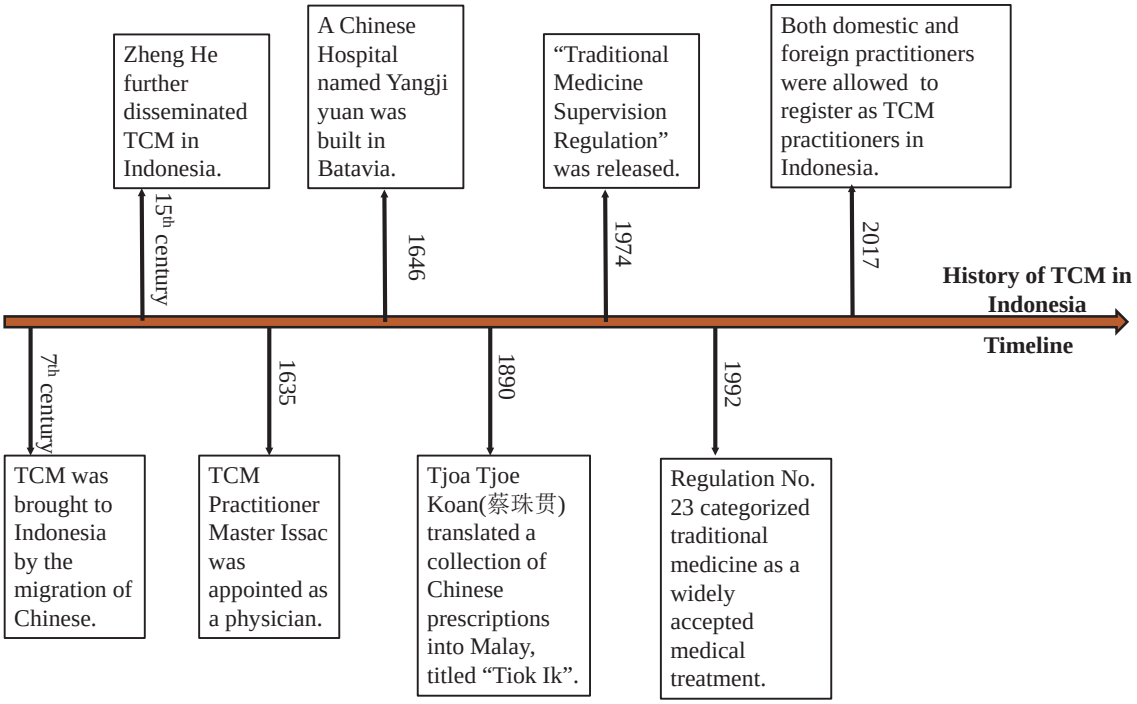

Figure 3 TCM history timeline in Indonesia (source with permission from: picture made by the authors)

Table 1 Comparison between Malaysia and Indonesia in the TCM management

Category	Malaysia	Indonesia
Government recognition	TCM was recognized in 1992 and integrated into public healthcare by 2007	TCM was recognized in 1992 but partially
Regulatory authority	National Pharmaceutical Regulatory Agency(NPRA) and Drug Control Authority (DCA)	Food and Drug Authority (BPOM)
Main regulations	2016 Traditional and Complementary Medicine Act; 1992 registration mandate for TCM products	2009 Health Law (Law No. 36/2009); Regulation of the Minister of Health No. 61 of 2016; 2018 Regulation No. 15 on complementary medicine
Tcm registration	Natural Products (Traditional Medicine & Herbal Products) requires ASEAN Common Technical Dossier (ACTD) compliance	Traditional Medicine follows Western pharmacopoeia standards; Halal certification was required since 2022
Healthcare system	TCM has been integrated into public hospitals since 2007	TCM is mainly offered by private sectors; Some of TCM has been integrated into public healthcare since 2001; TCM hasn't been covered by national health insurance coverage (JKN)

who wished to enhance their knowledge of medicine and acupuncture but could not afford long-term studies abroad. By 1959, 103 Indonesian students had enrolled in Xiamen University's "Internal Medicine of TCM" correspondence course. By 1965, this number had risen to 300, including studies in both internal medicine of TCM and acupuncture. Initially, most students opted for TCM courses, but over time, interest in acupuncture grew. This shift may be due to lower Chinese language requirements for acupuncture or a higher demand for acupuncture in Indonesia. After completing the correspondence courses, these students traveled to Xiamen University for in-person instruction and clinical internships. Upon graduation, they not only practiced medicine in Indonesia but also trained the next generation of TCM practitioners.[7,13,14]

In 1983, Jakarta, Indonesia, established the "Traditional Medicine School (Pusat Pendidikan Kesehatan Tradisional)", initiated by Indonesian Traditional Health Association (IKNI-Ikatan Kesehatan Tradisional Indonesia) and approved by the Indonesian government. The curriculum included basic TCM knowledge, acupuncture, and pharmacopoeia, taught in Indonesian by 19 Chinese practitioners. Among them was Phan Tho Fa, born around 1913 in Guangdong province (广东省), who learned TCM from an elderly physician and books before arriving in Java shortly before World War II. He practiced in Jakarta from the 1970s and became one of Indonesia's most senior TCM practitioners. In 1984, the first graduates received their degrees: 32 in TCM and 31 in acupuncture. The program lasted 4 to 5 years, using textbooks compiled by Shanghai University of Traditional

Chinese Medicine (上海中医药大学). Additionally, several Indonesian universities offer acupuncture programs. The Indonesian TCM Association frequently conducts short-term training courses. For example, the East Java Surabaya branch has held two acupuncture training sessions, each lasting 18 months, with graduates receiving a medical license recognized by the Indonesian Ministry of Health. Acupuncture textbooks and lectures are primarily in Indonesian, and similar short-term training programs are also offered by organizations such as the Jakarta Acupuncture Association and pharmaceutical guilds.[7,13]

In 2013, a milestone was reached with the introduction of the first bachelor's degree program in TCM at the Nalanda Buddhist College in East Jakarta, Indonesia. This development was made possible by regulations from the Ministry of Religious Affairs, which allowed for the establishment of a Buddhist medicine bachelor's degree, effectively aligning to the degree required for TCM. This initiative received support from the Director of Traditional Medical Care at the Ministry of Health and the professional organization for TCM practitioners, PKNI (Perhimpunan Kampus Nasional Indonesia). The course materials are in Indonesian, with additional classes in English and Chinese to enhance language skills. The tuition is relatively low, just a quarter of that at biomedical institutes. The program is open to students of all ages and backgrounds, especially traditional medical practitioners. It also provides early training in practical skills, such as acupuncture techniques, and students can obtain relevant certifications upon completion.[15]

5 Present cooperation between China and Indonesia on TCM

The cooperation between China and Indonesia in the field of medicine is rooted in a profound historical foundation and serves as a crucial component of China's global strategic approach to strengthening its relationship with Indonesia. TCM collaboration is integrated into the framework of the BRI, reflecting China's efforts to advance cultural and health diplomacy through soft power. In this process, TCM, as a valuable heritage of the Chinese nation, plays a role in disease prevention, treatment, and rehabilitation. It also serves as an important tool for China to promote TCM culture on the international stage. Current collaboration between the two countries in the field of TCM primarily focuses on three key areas: TCM research, TCM trade, and the cultivation of TCM professionals.

5.1 Cooperation on TCM research

Indonesia is home to 40,000 species of natural tropical plants, of which approximately 7,000 possess medicinal properties. The use of herbal medicine for treating illnesses has been a long-standing tradition in Indonesia. Meanwhile, China has distinct advantages in disease prevention, treatment, and rehabilitation through TCM. The cooperation between the two countries in the field of TCM reflects a complementary relationship.

In 2020, the International Cooperation Center of China's National Development and Reform Commission (NDRC) and Indonesia's Coordinating Ministry for Maritime Affairs and Investment signed a Memorandum of Understanding (MoU) aimed at promoting the joint establishment of a China-Indonesia Research and Innovation Center for Medicinal Plant Conservation. In November 2022, in the presence of the heads of state of both countries, the MoU on the joint development of the Indonesia-China Center for Conservation, Research, and Innovation of Medicinal Plants was officially signed. This initiative seeks to deepen collaboration in five key areas: the conservation, research, and development of medicinal plants; joint technological innovation; strengthening industrial cooperation in medicinal plants; establishing a joint research institute; and promoting talent exchange and capacity building.[16]

By 2023, several main buildings of the first phase of the project had been completed, and work on the cultivation and research of medicinal plants was gradually underway. Indonesia, the original proponent of the 21st Century Maritime Silk Road and a country rich in medicinal plant resources, has begun to collaborate collaborate with China to establish the Research and Innovation Center for Medicinal Plant Conservation, which not only aims to enhance the technological standards for the application of Indonesia's medicinal resources and bio-products but also promises significant economic benefits, contributing to the improvement of local livelihoods.

5.2 Cooperation on TCM trade

According to statistics, nearly 90% of China's imported medicinal materials originate from Asia. In 2023, the total value of medicinal material imports from the Asian market reached 410 million US dollars, with Indonesia being the largest supplier of Chinese medicinal herbs and decoction pieces, accounting for 143 million US dollars.[17] Traditional medicine is a key sector of trade between Indonesia and China, with significant potential for further development. For China, Indonesia, and the broader Southeast Asian region, not only represent vast market potential but also serve as a source of highly sought-after medicinal resources and health products, such as southern medicines (herbs commonly found in the southern regions of China and other parts of Southeast Asia) and bird's nest. Taiji Group, a well-known Chinese patent medicine company, provides a representative example. Since establishing its overseas business division in October 2015, the group has successfully registered its major products in Singapore, Indonesia, Malaysia,

and Thailand. In Indonesia, six products—*Huo Xiang Zheng Qi Ye* (藿香正气液 Agastache Qi-correcting Oral Liquid), *Bu Shen Yi Shou Jiao Nang* (补肾益寿胶囊 Kidney-supplementing Longevity Capsules), *Ji Zhi Tang Jiang* (急支糖浆 Syrup for Acute Bronchitis), *Er Kang Ning Tang Jiang* (儿康宁糖浆 Syrup for the Wellbeing of Children), *Chuan Long Gu Ci Pian* (穿龙骨刺片 Dioscoreae Nipponicae Bone Spur-reliving Tablets), and *Jiang Zhi Ling Pian* (降脂灵片 Blood Lipid-reducing Tablets)—have been registered. These products are sold in nearly 2,000 TCM shops across Indonesia, as well as in over 400 outlets of Indonesia's three largest Western medicine chain stores: Watsons, ROXY, and Mannings. The annual sales revenue from these products in Indonesia has approached 10 million Chinese Yuan.[18]

Guangzhou Cai Zhi Lin Pharmacy Pharmaceutical Chain Co. Ltd signed a strategic cooperation agreement with Indonesia's New World Specialty Products Trading Co., Ltd. Under this agreement, Cai Zhi Lin Pharmaceutical has procured nearly 10,000 tons of traditional Chinese medicinal materials, including Plumeria (commonly known as frangipani), from Indonesia Xintiandi Agricultural Specialty Trading Co., Ltd., with a total estimated value of approximately 1.3 billion Chinese Yuan. Furthermore, the two parties will actively engage in the cultivation, planting, breeding, and production processing of key medicinal materials and rare animal-derived medicinal ingredients. They plan to establish a joint research and development platform for traditional Chinese medicinal materials, collaboratively advancing standardization and key technologies in seed source development. This partnership aims to enhance the technological level and innovation capacity within the TCM industry.[19]

Zhang Zhou Pian Zai Huang (漳州片仔癀 Zhangzhou Pien Tze Huang) is a highly valuable traditional Chinese medicine, well-known both domestically and internationally, and enjoys a strong reputation in Indonesia. *Pian Zai Huang* is sold in 2,500 TCM pharmacies across Indonesia, with the Indonesian market accounting for 40% of its total overseas sales. In 2016, Pien Tze Huang Pharmaceutical Co., Ltd. partnered with Indonesia's largest TCM import agent, Sanyo Trading Indonesia, to establish a joint venture with an investment of 50 million US dollars. This venture aims to produce and sell traditional Chinese medicines, patent medicines, and daily chemical products, tailored to the prevalent diseases in Indonesia. Additionally, both parties will invest 30 million US dollars to jointly establish a base for the cultivation, breeding, and processing of medicinal materials (Fig. 4).[20]

The cooperation between Indonesia and China in the field of traditional medicine demonstrates tremendous development potential and vast prospects. As China's largest supplier of medicinal herbs, Indonesia not only provides China with abundant medicinal resources but has also become a significant market for various well-known Chinese pharmaceutical companies. Companies such as Taiji Group, Cai Zhi Lin Pharmacy, and Pien Tze Huang have successfully established stable sales channels in the Indonesian market through product registration, strategic partnerships, and joint ventures, while also participating in the cultivation and processing of medicinal materials. These collaborations not only promote the international development of TCM but also strengthen the bilateral cooperation in the field of health products and pharmaceuticals, showcasing the wide scope and great commercial potential of their partnership in this area.

Figure 4 An employee is seen sorting and organizing herbal ingredients at the Babah Kuya shop located in the Pasar Baru area of Bandung city (source with permissionfrom: https://www.ayobandung.com/baheula/pr-79729311/sudah-2-abad-di-kota-bandung-toko-herbal-babah-kuya-makin-laris-sejak-pandemi)

5.3 Cooperation on TCM education

In recent years, institutional exchange and communication between China and Indonesia have greatly advanced the development of TCM, demonstrating both countries' growing commitment to promoting TCM and integrating it with modern medical practices. These partnerships have highlighted the close ties between the two nations in the fields of culture, healthcare, and education. Through multi-level cooperation mechanisms and strategic agreements, significant progress has been made in TCM research, education, and medical services. This has not only facilitated the spread of TCM in Southeast Asia but also enhanced its role in the global healthcare system. Particularly under the "Health Silk Road" initiative, TCM cooperation between China and Indonesia has become more institutionalized, professionalized, and internationalized, making it an essential component of BRI.

In 2015, the inaugural meeting of the China-Indonesia Vice Premier-Level Cultural Exchange Mechanism was held in Jakarta, Indonesia. During this meeting, former Chinese Vice Premier Liu Yandong (刘延东) announced that, from 2015 to 2017, China would provide training for 100 Indonesian healthcare professionals. This exchange not only fulfills the consensus reached by the two countries' leaders to strengthen cooperation in areas such as education, science, culture, health, and youth,

but also reflects China's emphasis on Indonesia's status and influence in ASEAN. China is willing to align its "21st Century Maritime Silk Road" initiative with Indonesia's vision of a "world maritime axis".[21]

On January 9th, 2016, Yunnan University of Chinese Medicine (云南中医药大学) and Indonesia's Institut Ilmu Kesehatan formalized their collaboration through the signing of the "Yunnan University of Chinese Medicine-Indonesia Institut Ilmu Kesehatan Cooperation Agreement". This agreement, endorsed by Zhou Qing of Yunnan University of Chinese Medicine, Dr. R.P. Bambang Noerjanto, Dean of Institut Ilmu Kesehatan, and General Manager David R. Suhartono, outlines the joint development and implementation of undergraduate and non-degree TCM programs. This milestone establishes a robust foundation for the exchange and development of traditional medicine between China and Indonesia.[22] Furthermore, on December 7th, 2023, Hunan University of Chinese Medicine and Indonesia's Hang Tuah University launched the "Chinese Language + TCM Vocational Skills" training program. This initiative aims to enhance the understanding of TCM among Indonesian educators while simultaneously providing a platform for China to extend its cultural diplomacy and soft power.[23]

On February 10th, 2023, a tripartite agreement was signed by Indonesia's Udayana University, the Medical and Health Exchange and Cooperation Committee of the China-Asia Economic Development Association, and the First Affiliated Hospital of Tianjin University of Traditional Chinese Medicine. This agreement aims to establish a world-class rehabilitation and health center in Bali, combining TCM with advanced medical technology to enhance patient care and health outcomes. This center represents a strategic effort by both nations to advance global TCM practices and enhance health outcomes through innovative initiatives.[18] This reflects the deepening of cooperation between the two countries in TCM education. It not only facilitates the cultivation of TCM talents but also advances the development and innovation of TCM scientific research.

6 Conclusion

TCM has a long history in Indonesia, originating from the practice of the early immigrants and evolving into a more institutionalized and regulated healthcare service. In recent years, under the framework of BRI and Health Silk Road Initiative, China and Indonesia have carried out extensive cooperation in TCM with rich achievements. China has provided advanced methods for cultivating Chinese medicinal herbs, while Indonesia has exported valuable medicinal resources to China. In addition, China has actively supported the training of TCM professionals in Indonesia, effectively spreading TCM culture through talent exchanges, which fully reflects the unique role of TCM under the Health Silk Road initiative. Through the deepening of TCM trade, technological cooperation, and cultural and educational exchanges, the vigorous development of TCM in Indonesia has not only promoted its dissemination and innovation in Southeast Asia but also laid a solid foundation for its global expansion. Furthermore, TCM development in Indonesia highlights its great potential for further deepening health diplomacy in Southeast Asia.

Nevertheless, while the above achievements highlight the importance and promising future of TCM in Indonesia, there remains several obstacles that hinder its integration into the Indonesian healthcare system. The first challenge concern is halal certification. As a Muslim country, Indonesia has strict requirements on halal certification of medicines. Even though, most of the ingredients of TCM are derived from plants, the doubt of their halal status remains. Muti Arintawati, deputy director of Division of Auditing and Halal Assurance System at the Assessment Institute for Foods, Drugs and Cosmetics, the Indonesian Council of Ulama (LPPOM MUI), once argued: "Even though TCM is proved to be very effective for medical treatment and its ingredients are labeled halal, a closer inspection reveals that, some of them contain animal blood, which is forbidden for Muslims. Therefore, these products must undergo rigorous halal certification". As a result, the approval process for certain TCM products is often lengthy.[24] The second challenge is regulatory supervision. In most of the Southeast Asian countries, such as Singapore, Malaysia and Thailand, the registration of TCM follows the Chinese pharmacopoeia. However, in Indonesia, it has to follow the pharmacopoeia of Western medicine, which takes a rather long time for registration.[25] The last challenge concerns insurance. Even though TCM is widely preferred by Indonesians, it hasn't been included in Jaminan Kesehatan Nasional (JKN), the national health insurance of Indonesia. This situation, to some extent, affects the utilization of TCM for some Indonesian citizens.[26]

In conclusion, while TCM in Indonesia continues to encounter regulatory, religious, and institutional challenges, the broader trajectory of TCM development remains positive. With the long history of TCM in Indonesia and the bilateral initiatives under the Belt and Road and Health Silk Road frameworks, TCM has gradually evolved from a community-based tradition to a regulated medical practice in Indonesia. Through the rising acceptance and the increasing emphasis on natural and preventive medicine, TCM is expected to expand its footprint in Indonesia's health sector. Continued cooperation in pharmaceutical innovation, professional training, and policy harmonization will be essential to unlocking its full potential. Therefore, TCM is not only positioned to contribute to Indonesia's healthcare diversification but also to strengthen China–Indonesia health diplomacy and foster broader regional collaboration in public health.

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Ethical approval

This study does not contain any studies with human or animal subjects performed by any of the authors.

Author contributions

LIU Jiangwei drafted the manuscript, designed the graphical abstract and the tables. Taufik drafted the manuscript and reviewed the final version. Sity Daud reviewed, and edited the final version of the manuscript. All authors reviewed and approved the final version of the manuscript.

Conflicts of interest

The authors declare no financial or other conflicts of interest.

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Knowledge, Attitude, Behavior of Malay Community towards Traditional Chinese Medicine

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Abstract

Traditional Chinese medicine (TCM) was introduced to Malaysia in the 18th century by Chinese migrants and has since become a recognized part of the country's pluralistic healthcare system. In line with government efforts to formalize TCM practice, initiatives such as the establishment of the Traditional and Complementary Medicine (T&CM) Division in 2004 and the gazettement of the T&CM Act 2016 have been implemented. However, TCM remains underutilized among the Malay population, primarily due to cultural, religious, and linguistic factors. This paper explored the knowledge, attitudes, and behavior patterns regarding TCM of Malay people who visited the Urban Transformation Centre (UTC) in Shah Alam between October 2023 and January 2024. A cross-sectional survey was conducted at UTC Shah Alam in Selangor, Malaysia, using stratified sampling. A validated questionnaire was used to assess demographic information, knowledge, attitudes, and behavior patterns related to TCM. Among the respondents, both attitude and behavior pattern scores were generally positive. Financial status was identified as a significant factor influencing both attitudes and behavior patterns. Halal certification was identified as a key factor affecting the acceptance of Chinese herbal medicine. The findings suggest that possible pathways to broaden engagement would include increased availability of halal-certified TCM products, and clearer regulatory guidelines. Collaborative efforts that respect and incorporate local traditional practices, alongside support for localized TCM education, may contribute to greater inclusion. This localized model not only addresses specific community health challenges, but also offers perspectives into the potential role of traditional medicine in the global health landscape through cultural exchange and mutual learning.

Keywords: Malaysia; Malay; Traditional Chinese medicine; Halal; Cultural exchange

1 Introduction

1.1 Historical development of traditional Chinese medicine in Malaysia

In Malaysia, traditional Chinese medicine (TCM) is one of the seven recognized practice areas under the Traditional and Complementary Medicine (T&CM), alongside traditional Malay medicine, traditional Indian medicine, Islamic medical practice, homeopathy, chiropractic, and osteopathy. TCM has deep historical roots in Malaysia, introduced primarily through waves of Chinese migration during the 18th and 19th centuries under British governance. Chinese migrants brought with them herbal remedies, acupuncture, and massage traditions, establishing early medical halls and clan-based pharmacies, such as Penang's Yin Oi Tong (仁爱堂, 1796) and Kuala Lumpur's Chha Yong Fay Choon Kuan (茶阳回春馆, 1879), which served as both healthcare providers and community support hubs for the Chinese immigrants (Fig. 1).[1,2] Over time, TCM evolved from an ethnically-bound practice to a recognized component of Malaysia's pluralistic healthcare system.

1.2 Institutionalization and policy integration

The institutionalization of TCM in Malaysia was accelerated in the late 20th and early 21st centuries. Traditional medicine products are required to register with the National Pharmaceutical Regulatory Agency (NPRA) starting from 1992.[3] The Herbal Medicines Research Centre (HMRC) was established in 2000, and the National Policy on T&CM was introduced in 2001, later revised in 2007.[3] In 2002, the Global Information Hub on Integrated Medicine (GlobinMed) and the National Committee in Research and Development for Herbal

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Figure 1 The earliest Chinese medical hall, Yin Oi Tong (仁愛堂) established in 1796 in the Penang Island, which subsequently became part of the British Straits Settlements (source with permission from: photo taken by the authors)

Figure 2 IMU University, one of the leading local universities offering traditional Chinese medicine program in full English catering to non-Chinese students in Malaysia (source with permission from: photo taken by the authors)

Medicines were created.[3] These developments marked the beginning of government efforts to integrate T&CM into the national healthcare system. They also culminated in the formation of the T&CM Division under the Ministry of Health in 2004 as the national authority to regulate T&CM practice and practitioners.[3,4] Since then, the T&CM Division has undertaken multiple initiatives to ensure the safety, quality, and accessibility of T&CM. These include the integration of selected TCM services, such as acupuncture into public hospitals, the standardization and accreditation of T&CM training programs, public education to promote safe use, and the strengthening of collaborative research.[3–6]

A major milestone was the enactment of the T&CM Act 2016 (Act 775) which provides a legal framework for practitioner registration, product safety assurance, and service governance, aligning Malaysia's approach with the WHO Traditional Medicine Strategy 2014–2023 and the Regional Strategy for Traditional Medicine in the Western Pacific (2011–2020).[3,6] These policy advancements are complemented by planning shown in the T&CM Blueprint 2018–2027, which set a 5-year goal for service integration and sector development.[6–8] Academic programs, such as degree-level TCM courses in local universities (Fig. 2), and collaborative research initiatives have further legitimized the T&CM role within Malaysia's pluralistic healthcare system.[3,9,10]

1.3 TCM and the Malays: utilization, knowledge gaps, and barriers

The Malaysia's national data indicates that 20% of Malaysians T&CM users reported using TCM between 2014 and 2015, with herbal therapies being the most common modality, followed by massage, acupuncture and moxibustion.[5] Despite this, the acceptance and utilization of TCM among the Malay population, which constitutes the largest ethnic group in Malaysia, remain underexplored.[1,11]

While TCM is one of the most widely practiced T&CM modalities in the country, existing studies primarily focus on the Chinese community.[12,13] The limited research on Malay perspectives toward TCM creates a gap in understanding how demographic factors influence the Malay people's willingness to adopt these treatments. Barriers such as language differences, cultural perceptions, and religious concerns—particularly regarding the halal status of herbal formulations—may contribute to this limited adoption.[12,13]

The halal concerns stem from both doctrinal obligations and social perceptions. On the religious (doctrinal) side, Islamic jurisprudence emphasizes that ingredients must not only be permissible (halal) but also prepared under proper conditions (*ṭayyib*) to align with spiritual and ethical standards.[14,16] Simultaneously, there are substantial social perception barriers: studies show that Muslim consumers explicitly look for halal logos and equate certification with safety and quality.[14–16] In the pharmaceutical context, the absence of transparent halal labeling and the lack of mandatory disclosure practices further heighten consumer skepticism.[17]

Several studies have assessed the general public's knowledge of TCM, with findings suggesting a lack of awareness among non-Chinese populations.[18] For instance, Ahmad, et al.[19] reported that 73.7% of pharmacy students in Malaysia had insufficient knowledge of TCM, despite demonstrating positive attitudes toward T&CM. However, the study did not examine ethnicity as a variable, making it unclear whether these findings are representative of the Malay community specifically. Additionally, while Kumar, et al.[12] found that 58.5% of Malaysians reported using TCM, the study's sample was predominantly Chinese (82.3%), further highlighting the need for research focused on the Malays.

Given these gaps in the literature, this study aimed to investigate the knowledge, attitudes and behavioral patterns of the Malay people who visited the Urban

Transformation Centre (UTC) Shah Alam toward TCM in Malaysia. By identifying knowledge gaps, assessing attitudes, and determining usage patterns, the findings would provide valuable insights for TCM practitioners and policymakers. This research would also help bridge cultural barriers by informing measures to enhance awareness, improve accessibility, and promote the safe and effective integration of TCM within Malaysia's multi-ethnic healthcare landscape.

2 Methods

This study was a descriptive, cross-sectional study utilizing a stratified random sampling method at government departments within UTC in Shah Alam, Selangor, which included the National Registration Department, Road Transport Department, etc., and is situated in a predominantly Malay city, from October 2023 to January 2024. A total of 130 respondents were recruited, and a stratified sampling based on age and gender proportions was employed to ensure that the sample distribution aligned with Malaysia's demographic statistics. After the researcher briefed the respondents face-to-face regarding the study, data was collected through a structured, self-administered questionnaire via Microsoft Forms.

2.1 Study design

The questionnaire was structured in a sequential format, primarily consisting of multiple-choice questions. It comprised four main domains: 1) Demographic profile of respondents; 2) Knowledge of TCM practices in Malaysia; 3) Attitudes toward TCM practices in Malaysia; 4) Behaviors related to TCM use in Malaysia. The questionnaire was adapted from two published research studies[10,15] with minor modifications to align with the study objectives and contextual adjustments relevant to the local setting. Validation of the modified questionnaire was done, and a pilot study was conducted to assess the reliability and consistency of the questionnaire.

To determine the optimal sample size, a systematic approach was used. The average monthly number of visitors to the administrative office at UTC Shah Alam served as the basis for calculations. Initially, the percentage of Malays in the Malaysian population was obtained from the Department of Statistics, Malaysia. This percentage was then applied to the estimated monthly number of Malay visitors at UTC Shah Alam, which was recorded as 3,000 individuals. Sample size was estimated using the Raosoft calculator (95% confidence, 5% margin of error). A 10% response distribution was applied, reflecting our a priori expectation of low TCM utilization among the Malays, informed by a brief pilot screen. With a Malay monthly visitor population of 1,740 (57.9% of 3,000), the minimum recommended sample size for the study was calculated to be 129 respondents.

2.2 Data collection

Prior to data collection, respondents were clearly informed that their participation was voluntary, and all information gathered would be kept private and confidential. They were also advised that they could withdraw from the study at any time without penalty or consequence. After obtaining informed consent, respondents were asked to scan a QR code using their own devices so that they were directed to the survey hosted on Microsoft Forms. Microsoft Forms was selected for its ability to facilitate online data collection and seamless exportation of responses into Microsoft Excel for further analysis. All data was recorded in real time. The inclusion criteria were Malay citizens aged 18 years or above who visited UTC Shah Alam between October 2023 and January 2024. The exclusion criteria excluded individuals unwilling to provide informed consent.

2.3 Data analysis

Data collected via the Microsoft Forms was exported to Microsoft Excel (version 2022) for initial sorting and organization. The dataset was then analyzed using the Statistical Package for the Social Sciences (SPSS) version 26. Descriptive statistics were used to summarize demographic distribution, knowledge, attitudes, and behavioral patterns of Malay people towards TCM practices in Malaysia.

Nominal data was categorized, while both nominal and ordinal data were summarized as percentages. The results were reported as means and standard deviations.

For knowledge-based questions, a 3-point Likert scale was employed:

- **Yes** = 2 points
- **No** = 0 points
- **Don't know** = 0 points

Both "No" and "Don't know" were grouped together because they suggested a lack of correct knowledge towards TCM.

For attitude- and behavior-related questions, a 5-point Likert scale was used:

- Strongly agree = 3 points
- Agree = 2 points
- Neutral = 1 point
- Disagree / Strongly disagree = 0 points

Chi-square test was applied to assess relationships between dependent variables (knowledge, attitudes, and behaviors) and independent variables (age, gender, ethnicity, place of residence, average household income, and educational background). The mean scores for knowledge, attitudes, and behaviors were calculated for each

individual question using the defined scoring system. A *p*-value < 0.05 was considered statistically significant in determining the acceptance or rejection of the study hypotheses.

3 Results

A total of 131 responses were collected, of which 1 response was excluded because the participant was aged below 18 years and did not meet the inclusion criteria. Thus, the final analysis included 130 valid responses. The total sample size was sufficient to estimate low-prevalent parameters used in this research.

3.1 Demographic characteristics of respondents: majority Malay males aged 31–40 years from low- to middle-income groups

As shown in table 1, a total of 130 respondents participated in the study, with 53.0% (*n* = 69) being male and 47.0% (*n* = 61) female, all identifying as Malay. The mean age of respondents was 34.31 years, with a median of 32.00 years old and an age range of 18 to 62 years. The majority of respondents resided in urban areas (63.1%, *n* = 82), followed by district areas (22.3%, *n* = 29) and municipalities (14.6%, *n* = 19). In terms of financial status, most belonged to the B40 income group (< RM5,000) (66.2%, *n* = 86), while 26.9% (*n* = 35) were in the M40 income group (RM5,001 – RM9,999) and 6.9% (*n* = 9) in the T20 income group (RM10,000). Regarding education level, 81.5% (*n* = 106) respondents had diploma or higher degrees, 16.2% (*n* = 21) only completed secondary school education, 1.5% (*n* = 2) had only primary school education, and 0.8% (*n* = 1) had no formal education (Table 1).

3.2 Patterns of TCM utilization: low prevalence with preference for Chinese herbal medicine and acupuncture

The majority of respondents (77.69%, *n* = 101) had never used TCM, while only 22.31% (*n* = 29) had prior experience with TCM. Among TCM users, the most commonly utilized treatment modality was Chinese herbal medicine (72.41%, *n* = 21), followed by acupuncture and moxibustion (41.38%, *n* = 12), Chinese cupping (20.69%, *n* = 6), and *Tui Na* (推拿) massage therapy (13.79%, *n* = 4) (Table 2). Based on the 5-point Likert scale stated in the methodology, a weighted average user satisfaction score was calculated for each treatment modality. All respondents gave a positive satisfactory rating ranging from "Strongly agree" to "Neutral" for all treatment modalities. Among the respondents with prior TCM experience, Chinese cupping (83.33% ± 0.50%) had the highest weighted average satisfactory score, followed by *Tui Na* massage therapy (75.00% ± 0.43%). The lower weighted average satisfactory scores were seen in Chinese herbal medicine (61.90% ± 0.56%) and acupuncture and moxibustion (61.11% ± 0.80%).

According to the survey, 33.33% (*n* = 9) of TCM users had tried more than one type of treatment modality. When asked about their reasons for choosing TCM, respondents were allowed to select multiple answers. The most common reasons included recommendations from family and relatives (44.83%, *n* = 13), confidence in TCM treatment efficacy (41.38%, *n* = 12), dissatisfaction

Table 1 Demographic characteristics of respondents

Demographics	Description	*n*	Proportion (%)
Gender	Male	69	53.00
	Female	61	47.00
Age	18–29 years old	53	40.77
	30–39 years old	40	30.77
	40–49 years old	22	16.92
	50–59 years old	14	10.77
	60–69 years old	1	0.77
Place of residence	Cities	82	63.07
	Municipalities	19	14.62
	District	29	22.31
Financial status (monthly salary)	B40 < RM5,000	86	66.15
	M40 RM5,001 – RM9,999	35	26.92
	T20 RM10,000	9	6.92
Education level	No formal education	1	0.77
	Primary school	2	1.54
	Secondary school	21	16.15
	Diploma and above	106	81.54

Table 2 Utilization and satisfaction rates of TCM treatment modalities

Treatment Modality	Total Respondent (*n*)	Utilization Rate (%)	Respondent for Each Satisfaction Level (*n*)		Satisfaction Rate (%)	Weighted Average Satisfaction Score with Standard Deviation (%)
Chinese herbal medicine	21	72.41	Strongly agree	2	9.52	61.90 ± 0.56
			Agree	14	66.67	
			Neutral	5	23.81	
			Disagree/Strongly disagree	0	0.00	
Acupuncture and moxibustion	12	41.38	Strongly agree	3	25.00	61.11 ± 0.80
			Agree	4	33.33	
			Neutral	5	41.67	
			Disagree/Strongly disagree	0	0.00	
Chinese cupping	6	20.69	Strongly agree	3	50.00	83.33 ± 0.50
			Agree	3	50.00	
			Neutral	0	0.00	
			Disagree/Strongly disagree	0	0.00	
Tui Na massage therapy	4	13.79	Strongly agree	1	25.00	75.00 ± 0.43
			Agree	3	75.00	
			Neutral	0	0.00	
			Disagree/Strongly disagree	0	0.00	

with modern medicine (24.14%, *n* = 7), preference for less invasive treatment methods (24.14%, *n* = 7), and affordability and accessibility of TCM (24.14%, *n* = 7) (Table 3).

3.3 Knowledge concerning TCM: limited understanding of modalities, regulation, and policy framework

The knowledge domain was assessed using a 25-mark scoring system, in which a score above 80% indicated good knowledge, 50%–79% indicated moderate knowledge, and less than 50% indicated poor knowledge. The score was calculated based on the correct answer in each question using the 3-point Likert scale stated in the methodology. The overall weighted mean knowledge score among respondents was 10.01 out of 25 (40.03%), indicating poor knowledge of TCM among the Malay respondents.

Table 3 Reasons for choosing TCM

Reasons for Choosing TCM	*n*	Percentage (%)
Recommended by family and relatives	13	44.83
Confident in TCM treatment efficacies	12	41.38
Tried modern medicine but was unsatisfactory with the result	7	24.14
Less invasive method to treat diseases	7	24.14
Less expensive and easily accessible	7	24.14
Recommended by doctors or physicians	5	17.24
Recommended by close friends	4	13.79
Recommended by social media influencers	2	6.90

The highest mean knowledge score (49.49%) was for the statement regarding the list of TCM treatment modalities available in Malaysia. Conversely, the lowest mean knowledge score (16.15%) was for the statement, "Traditional Chinese medicine (TCM) is not regulated by the Ministry of Health (MOH) Malaysia as one of the traditional and complementary medicines" (Table 4).

Awareness of Chinese herbal medicine, acupuncture/moxibustion as part of TCM treatment modalities was relatively high, to which 91.54% and 80.77% of the respondents were aware of these modalities respectively. 67.69% and 56.92% of the respondents were aware of Chinese cupping therapy and *Tui Na* massage therapy, suggesting these modalities were relatively less well-known among the respondents.

3.4 Attitude toward TCM: generally positive perceptions despite limited knowledge

In the attitude domain, a score above 50% was considered indicative of a positive attitude, while a score below 50% was classified as a negative attitude. The overall weighted mean attitude score among the Malay respondents was 12.92 ± 4.43 out of a total of 24, equating to 53.81%, which suggests a generally positive attitude toward TCM.

The statement with the highest weighted mean score (67.69% ± 0.75%) was, "Scientific research in TCM should be strengthened and intensified". Conversely, the lowest weighted mean score (43.08% ± 0.82%) was observed for the statement, "I am confident in the halal status of Chinese herbal medicine" (Table 5).

Table 4 Knowledge score concerning TCM

Statements in the Knowledge Domain	*n*	Percentage (%)	Weighted Mean Score
Traditional Chinese medicine (TCM) is NOT regulated by the Ministry of Health Malaysia as one of the traditional and complementary medicines	130		16.15
Correct response	21	16.15	
Incorrect response	46	35.38	
Don't know	63	48.46	
Currently, TCM is part of national healthcare system in Malaysia	130		40.77
Correct response	53	40.77	
Incorrect response	22	16.92	
Don't know	55	42.31	
TCM treatment is offered at the Traditional and Complementary Medicine (T&CM) unit of some Malaysia government hospitals for chronic pain, post-stroke condition, adjunct therapy for cancer and other health conditions	130		38.46
Correct response	50	38.46	
Incorrect response	13	10.00	
Don't know	67	51.54	
Which of the following are the TCM treatment modalities?	581		49.49
Chinese herbal medicine	119	91.54	
Ayurvedic treatment	20	15.38	
Acupuncture and moxibustion	105	80.77	
Chiropractic treatment	45	34.62	
Chinese cupping therapy	88	67.69	
Tui Na (推拿) massage therapy	74	56.92	
Chinese herbal medicine only consists of herbal but not mineral and animal-derived products	130		24.62
Correct response	32	24.62	
Incorrect response	65	50.00	
Don't know	33	25.38	
TCM treatment philosophy has been systematically developed, recorded in various medical classics manuscript and continuously in practice since 2000 years ago	130		48.46
Correct response	63	48.46	
Incorrect response	3	2.31	
Don't know	64	49.23	
Which of the following products are used in TCM herbal formulae?	716		36.98
Ginger	112	86.15	
Galangal	45	34.62	
Turmeric	70	53.85	
Cinnamon	65	50.00	
Star anise	58	44.62	
Black pepper	64	49.23	
Rosemary leaves	53	40.77	
Andrographis panniculata	46	35.38	
Macrocarpa phaleria	39	30.00	
Eurycoma longifolia	52	40.00	
Cicadas slough	37	28.46	
Water buffalo horn	30	23.08	
Gypsum fibrosum	45	34.62	

Table 5 Attitude score concerning TCM

Statements	Respondent for Each Agreement Level (*n*)		Percentage (%)	Weighted Mean Score with Standard Deviation (%)
I believe in the efficacy of Chinese herbal medicine in treating many diseases	Strongly agree	13	10.00	53.33 ± 0.73
	Agree	58	44.62	
	Neutral	53	40.77	
	Disagree/Strongly disagree	6	4.62	
I am confident with the halal status of the Chinese herbal medicine	Strongly agree	11	8.46	43.08 ± 0.82
	Agree	35	26.92	
	Neutral	65	50.00	
	Disagree/Strongly disagree	19	14.62	
I believed in the efficacy of acupuncture and moxibustion in treating many diseases	Strongly agree	12	9.23	55.38 ± 0.70
	Agree	67	51.54	
	Neutral	46	35.38	
	Disagree/Strongly disagree	5	3.85	
I believed in the efficacy of Chinese cupping therapy in treating many diseases	Strongly agree	14	10.77	52.82 ± 0.73
	Agree	53	40.77	
	Neutral	58	44.62	
	Disagree/Strongly disagree	5	3.85	
I believed in the efficacy of *Tui Na* massage therapy in treating many diseases	Strongly agree	11	8.46	45.13 ± 0.75
	Agree	35	26.92	
	Neutral	73	56.15	
	Disagree/Strongly disagree	11	8.46	
I believe TCM treatment has low risk and less side effects	Strongly agree	17	13.08	50.51 ± 0.80
	Agree	41	31.54	
	Neutral	64	49.23	
	Disagree/Strongly disagree	8	6.15	
I think that TCM treatment should be popularized and advocated to the public	Strongly agree	27	20.77	62.56 ± 0.74
	Agree	62	47.69	
	Neutral	39	30.00	
	Disagree/Strongly disagree	2	1.54	
Scientific research in TCM should be strengthened and intensified	Strongly agree	38	29.23	67.69 ± 0.75
	Agree	59	45.38	
	Neutral	32	24.62	
	Disagree/Strongly disagree	1	0.77	

3.5 Behaviors toward TCM: positive inclination influenced by halal certification

In the behavioral domain, a score above 50% is considered positive, while a score below 50% is considered negative. The overall weighted mean score for the behavioral domain was 11.62 out of 21, with a standard deviation of 3.379, translating to 55.35%. These results indicate an overall positive behavior toward TCM among the Malay respondents. Additionally, each treatment modality received a score above 50%, further demonstrating a generally favorable attitude toward TCM practices.

The statement with the highest weighted mean behavior score (72.05% ± 0.83%) was, "I am willing to consume Chinese herbal medicine only if it is halal-certified by JAKIM (Jabatan Kemajuan Islam Malaysia or otherwise known as the Department of Islamic Development Malaysia) or any Foreign Halal Certification Bodies (FHCB)". In contrast, the lowest mean score (37.69 ± 0.96%) was for the statement, "I am willing to consume Chinese herbal medicine even if it is not halal-certified, provided it is derived solely from plant origins" (Table 6).

3.6 Correlations between knowledge, attitude, behaviors and demographics: financial status as the only significant predictor

Chi-square test was performed to find statistical relationships between knowledge, attitudes, behaviors, and social demographics. According to table 7, the chi-square test indicated no statistically significant association between age group, gender, place of residence, education level, and TCM utilization with knowledge level of TCM among respondents. However, there was significant association between the weighted mean knowledge score with financial status ($p < 0.05$).

Similarly, the chi-square test indicated no statistically significant difference between the weighted mean attitude scores and age group, gender, places of residence, or education level (Table 7). However, a significant difference was observed when comparing the attitude domain with TCM utilization among respondents and financial status ($p < 0.05$). Only 47.11% of respondents from B40 and M40 households exhibited a positive attitude

Table 6 Behavior score concerning TCM

Statements	Respondent for Each Agreement Level (*n*)		Percentage (%)	Weighted Mean Score with Standard Deviation (%)
I am willing to consume Chinese herbal medicine to treat diseases	Strongly agree	11	8.46	51.79 ± 0.69
	Agree	54	41.54	
	Neutral	61	46.92	
	Disagree/Strongly disagree	4	3.08	
I am willing to consume Chinese herbal medicine even if they don't have halal certification, provided they come from solely plant origin	Strongly agree	9	6.92	37.69 ± 0.96
	Agree	42	32.31	
	Neutral	36	27.69	
	Disagree/Strongly disagree	43	33.08	
I am willing to consume Chinese herbal medicine only if they are halal certified by JAKIM or any Foreign Halal Certification Bodies (FHCB)	Strongly agree	54	41.54	72.05 ± 0.83
	Agree	46	35.38	
	Neutral	27	20.77	
	Disagree/Strongly disagree	3	2.31	
I am willing to receive acupuncture and moxibustion to treat diseases	Strongly agree	13	10.00	55.64 ± 0.68
	Agree	64	49.23	
	Neutral	50	38.46	
	Disagree/Strongly disagree	3	2.31	
I am willing to receive Chinese cupping therapy to treat diseases	Strongly agree	11	8.46	54.87 ± 0.68
	Agree	66	50.77	
	Neutral	49	37.69	
	Disagree/Strongly disagree	4	3.08	
I am willing to receive *Tui Na* massage therapy to treat diseases	Strongly agree	10	7.69	51.79 ± 0.69
	Agree	57	43.85	
	Neutral	58	44.62	
	Disagree/Strongly disagree	5	3.85	
How likely are you to recommend TCM to other people?	Scale 0	1	0.77	63.62 ± 1.86
	Scale 1	0	0	
	Scale 2	1	0.77	
	Scale 3	7	5.38	
	Scale 4	5	3.85	
	Scale 5	35	26.92	
	Scale 6	18	13.85	
	Scale 7	23	17.69	
	Scale 8	26	20.00	
	Scale 9	8	6.15	
	Scale 10	6	4.62	

Table 7 *P*-value for the comparison of knowledge, attitudes and behaviors by demographic data and TCM utilization

Demographic and TCM Utilization	Knowledge	Attitude	Behavior
Age group	0.518	0.442	0.290
Gender	0.121	0.991	0.813
Place of living	0.632	0.516	0.444
Financial status	0.730	0.006*	0.031*
Education level	0.930	0.366	0.677
TCM utilization	0.005*	0.008*	0.084

*Significant at 0.05 level or smaller.

toward TCM, whereas all respondents from T20 households demonstrated a positive attitude. Additionally, 72.41% of TCM users had a positive attitude toward TCM, compared to only 44.55% of non-TCM users.

The chi-square test also revealed a statistically significant difference in behavioral patterns based on financial status ($p < 0.05$), as shown in table 7. The results indicated that all respondents from the T20 income group (100.00%) exhibited positive behaviors toward TCM, whereas only 55.37% of those from the B40 and M40 groups demonstrated positive behaviors. However, no statistically significant differences were observed in behavioral patterns across different age groups, gender, place of residence, education level, or TCM utilization.

4 Discussion

4.1 TCM utilization: low adoption shaped by cultural and religious influences

The study revealed that only 29 out of 130 respondents (22.31%) had previously tried TCM, reflecting a low usage rate. This low adoption rate may be influenced by cultural and historical differences between traditional Malay medicine (*Perubatan Melayu*) and TCM. Unlike TCM, which has an extensive written history and systematic theoretical framework, traditional Malay medicine relies heavily on oral transmission and is influenced by Islamic principles.[16] Islamic teachings significantly shape Malay healthcare behaviors by emphasizing spiritual healing modalities such as *doa*, *jampi*, and *ruqyah*, and by strictly prohibiting substances considered *haram* (e.g., alcohol, certain animal products).[20] This religious framework may affect perceptions of TCM and extend beyond concerns about halal certification alone. For example, even plant-based herbal remedies may be mistrusted if their spiritual or medicinal lineage is unclear.[21] As a result, in addition to general concerns about the halal status of Chinese herbal medicine products, there may be a deeper cultural hesitation rooted in perceived philosophical or spiritual incompatibilities between TCM and Islam. This may explain why a substantial proportion of Malay respondents in the study expressed reluctance to use TCM without halal certification even when the treatment is plant-based. Efforts to align TCM practices with Islamic values, such as providing transparent ingredient sourcing, employing Muslim practitioners to foster cultural trust, or obtaining certification from trusted religious bodies like JAKIM, may help bridge this cultural gap and promote integrative, pluralistic healthcare in Malaysia.

The gender distribution showed a slight predominance of females (58.62%) among TCM users, with males accounting for 41.38%. This aligns with findings by Kumar et al., who reported a higher proportion of female TCM users (1.16: 1 ratio).[12] Traditionally, women in Malay culture are more inclined to seek alternative medicine, particularly for reproductive health, which may explain the higher female participation in TCM. According to Aziz and Tey,[21] women are 1.8 times more likely to use herbal medicines than men, although their study did not specify Chinese herbs.

Among the various TCM modalities, Chinese herbal medicine was used the most commonly (72.41%), followed by acupuncture and moxibustion (41.38%). The preference for herbal medicine is reflective of both TCM and traditional Malay medicine, to which plant-based remedies play a fundamental role. Chinese cupping (20.69%) and *Tui Na* massage therapy (13.79%) were less commonly utilized, possibly due to limited public awareness of these treatments. Chinese cupping has a lower usage likely because of its similarity with *bekam* (Malay bloodletting cupping) in traditional Malay medicine. The Malays are familiar with *bekam* but they are unfamiliar with Chinese cupping. Thus, they would resort to *bekam* instead. It is also because of the familiarity that Chinese cupping received the highest satisfaction rate among all TCM treatment modalities. While *Tui Na* shares similarities with *urut* (Malay massage therapy), the lack of familiarity with Chinese terminology may contribute to the lower usage rate among Malays.[22]

Satisfaction rates for TCM treatments, measured using 5-point Likert scale, were high, with Chinese cupping receiving the highest rating (83.3% ± 0.50%), followed by *Tui Na* massage therapy (75.0% ± 0.43%), Chinese herbal medicine (61.9% ± 0.56%), and acupuncture and moxibustion (61.1% ± 0.80%). However, the small sample size for cupping and *Tui Na* may have influenced the high satisfaction rates. Although Chinese cupping was less commonly used due to preference for *bekam*, those

who tried it reported high satisfaction, likely reflecting recognition of their similarities. Common reasons for choosing TCM included recommendations from family and friends, confidence in TCM efficacy, dissatisfaction with modern medicine, and the less invasive nature of TCM treatments. This aligns with traditional Malay medicine practices, where family and community play a significant role in influencing healthcare choices. These findings are consistent with Kumar, et al.'s study, which also identified family and friend recommendations, trust in TCM, and dissatisfaction with modern medicine as key factors influencing the choice of TCM.[12]

4.2 Knowledge of TCM: limited understanding and cultural intermixing

The study found that some respondents mistakenly considered chiropractic and Ayurvedic practices as part of TCM, reflecting a general lack of understanding about T&CM in Malaysia. These findings suggest that educational initiatives could help improve public awareness of TCM and its various treatment modalities. A cultural factor contributing to this confusion may be Malaysia's multiethnic society, where elements of different T&CM systems have intermingled. This situation may also reflect the developmental dynamics of TCM within Malaysia's plural medical landscape.[7] When TCM alone lacks sufficient visibility or economic viability, practitioners might incorporate or blend techniques from other systems, such as chiropractic or physiotherapy, to appeal to a broader clientele. Such integration likely represents a pragmatic response to market pressures rather than a dilution of tradition.

However, this blending could contribute to public misperception, where TCM is seen less as a distinct system and more as an adaptable hybrid. Further investigation into how practitioners balance cultural authenticity and economic sustainability, especially in terms of licensing under the Traditional & Complementary Medicine Act and professional registration, would shed light on the perception of TCM's identity in Malaysia.

The poorest knowledge score (16.15%) was observed regarding the regulation of TCM by the Ministry of Health, Malaysia. Despite the establishment of T&CM units in at least 14 government hospitals, this lack of awareness points to the value of enhancing public information about the regulation and integration of TCM into the public healthcare system.. In Malaysia, the regulation of TCM herbal medicines and practitioners is a multistep, often lengthy process. Phased implementation—from forming the T&CM Council (2017) to mandatory practitioner registration in 2021 and final enforcement in 2024—highlights both the complexity and substantial time commitment required to fully regulate TCM in Malaysia.[23]

Similarly, only 24.62% of respondents were aware of the presence of animal and mineral herbs in TCM, suggesting limited knowledge of TCM herbal treatments. However, it is important to note that TCM herbal formulas can still be tailored for individuals with dietary or religious restrictions, using plant-based ingredients. This represents an advantage in serving Malay consumers, who prioritize halal compliance due to religious practice.

4.3 Attitude toward TCM: socioeconomic influence, halal concerns, and modernization outlook

The more favorable attitudes observed among T20 respondents may be attributable to their greater exposure to integrative healthcare settings, where TCM is more commonly available alongside conventional medicine. Higher socioeconomic status may also facilitate access to health information and afford the cost of TCM treatments, hence contributing to a more positive perception. These factors suggest that the attitudinal differences in our study may reflect social differences in healthcare rather than intrinsic variations in cultural acceptance.

The lowest attitude score was recorded for confidence in the halal status of Chinese herbal medicines, with only 43.08% ± 0.82% of respondents expressing confidence in this regard. This aligns with previous studies indicating that the Malay community is hesitant to use herbal medications if the ingredients' halal status is unclear.[23,24] Single medicines or individual herbs such as ginseng or ginger are often plant-based and easier to assess for halal status. In contrast, compound formulas may combine multiple ingredients, sometimes including animal products (e.g., deer antler) or alcohol as a solvent, making halal certification more complex. Nevertheless, as Malay community accounts for 58.1% of the total population in Malaysia, obtaining halal certification for Chinese herbal medicine may be helpful to penetrate such an untap market.[25]

In contrast, the highest attitude score was for the statement advocating for increased scientific research into TCM, indicating a potential pathway for the modernization of TCM to gain greater trust from the scientific Malay community. This is consistent with the education profile of the respondents, viz. 82% of whom are graduates from tertiary education.

Attitudes toward specific TCM modalities were generally positive, with Chinese herbal medicine and acupuncture/moxibustion scoring 53.33% ± 0.73% and 55.38% ± 0.70%, respectively. However, *Tui Na* received the lowest score (45.13% ± 0.75%), likely due to a lack of awareness about this modality within the Malay respondents. The preference for acupuncture over *Tui Na* may be attributed to greater public exposure, as acupuncture has successfully integrated into Malaysian public healthcare facilities in all states while *Tui Na* is not yet widely available in clinical settings. The relatively successful integration of acupuncture into public

hospitals such as in Hospital Kepala Batas and Hospital Putrajaya demonstrates that institutional support, practitioner regulation, and clinical research may be key factors for gaining mainstream acceptance. Based on these findings, the expansion of *Tui Na* into public health services would benefit from establishing clearer practice guidelines, conducting more local efficacy studies, and strengthening collaboration with medical professionals.

4.4 Behaviors toward TCM: halal certification, global implications, and cultural integration

The behavioral patterns domain revealed an overall positive attitude of the Malay respondents towards TCM, with an average score of 55.35%. Notably, respondents showed a strong preference for Chinese herbal medicine with halal certification, with 72.05% ± 0.83% indicating they would consume if it is certified. This suggests that halal certification plays a crucial role in the decision-making process for the Malay respondents. Conversely, a significant proportion (37.69% ± 0.96%) expressed reluctance to consume Chinese herbal medicine without halal certification, even if the medicine was plant-based. These findings emphasize the importance of halal certification in encouraging TCM adoption among the Malay population.

The results of these findings extend beyond Malaysia, carrying implications for broader global Muslim population, who share similar religious principles concerning the halal status and certification of traditional Chinese herbal medicine. Consequently, the study highlights the growing necessity for the development and recognition of halal-certified herbal medicine, not only for clinical application in Malaysia but also across regions with significant Muslim communities. Although gaining halal certification in Malaysia does not automatically guarantee recognition in other countries, Malaysia's JAKIM certification is widely respected and considered a global leader in the halal industry. In 2023, for the 10th consecutive year, Malaysia led the Global Islamic Economy Indicator (GIEI), ranking first in sectors including Islamic finance, halal food, and media & recreation. JAKIM's halal certification is recognized in over 47 countries and has endorsed 84 certification bodies globally, increasing international acceptance among Muslim communities.[26–28]

Additionally, many respondents were hesitant to recommend TCM to others due to their own limited experience with these treatments. The findings suggest potential for expanding medical outreach and education programs to improve awareness and understanding of TCM among the broader Malaysian population. Promoting knowledge of historical connections between TCM and traditional Malay medicine, especially their shared use of plant-based therapies, could support acceptance within the Malay community. Emphasizing overlapping concepts, such as the hot-cold theory (*panas-sejuk*) in Malay medicine and yin-yang (阴阳) theory in TCM, may also strengthen cultural relevance. Community-oriented approaches, including offering charity TCM clinics in the rural areas, halal-certified TCM products, multilingual educational resources, and engagement with Islamic scholars, could further facilitate cultural acceptance and integration. These efforts could help present TCM not as an external practice, but as a system with shared health philosophies, which align with Malaysia's diverse healthcare landscape.

5 Limitations

This study has several limitations, particularly in terms of the data collection method. The data was collected using Microsoft Forms, an online questionnaire platform, which posed challenges for some respondents. Due to recent concerns about online spam and scam activities around UTC Shah Alam, some individuals were reluctant to scan the QR code using their smartphones. Additionally, recruitment at a government service center may create bias toward selection of individuals. These individuals are usually young working adults, more tech-savvy and have access to smartphones. Older retirees who are not tech-savvy may have difficulty completing the survey. For future studies, it is suggested to offer interviewer-assistance and paper or hybrid options to ensure diverse participants and equitable access while at the same time reducing the digital divide.

While using hardcopy paper forms was considered, it may not be ideal as certain questions or statements would need to be hidden based on respondents' eligibility, which could lead to confusion. Moreover, some respondents might hesitate to provide sensitive information, such as their financial status or educational level, and others could provide inaccurate responses by randomly selecting answers, compromising the data's reliability.

Our scoring approach may have reduced response granularity, as "No" and "Don't know" in knowledge questions, and both forms of disagreement in attitude questions, were given the same score. This simplification facilitated analysis but may have obscured distinctions; future studies could adopt more nuanced scoring systems such as symmetrical Likert scale.

Participants were recruited at UTC Shah Alam, an urban government service hub in a Malay-majority city. Although the site provides high foot traffic and efficient access to diverse walk-in clients, it likely over-represents the urban, employed, and highly educated Malays. Some of these respondents may be public servants, which may cause selection bias. As a single-site, cross-sectional stratified survey, the small sample size (n = 130) is not representative of the knowledge, attitudes, and behaviors of the broader Malay population in Malaysia. The sample size was estimated using a 10% response distribution, based on pilot observations indicating a relatively low

prevalence of TCM use among the Malays. While this approach is appropriate for detecting low-prevalent outcomes, it yields a smaller minimum sample and may be underpowered. Therefore, further studies with larger sample size conducted across multiple urban and rural regions are needed to provide greater precision and generalizability across the wider Malay population.

6 Suggestions moving forward for TCM in Malaysia

Although this study found that TCM utilization among Malay respondents in UTC Shah Alam was relatively low, attitudes and behaviors were generally positive, particularly toward Chinese herbal medicine and acupuncture. However, limited knowledge suggests that willingness to use TCM may occur without full understanding of its principles, benefits, or safety, underscoring the need for improved health literacy. Financial status was the only demographic factor significantly shaping attitudes, while halal certification emerged as a key determinant of acceptance, reflecting the deep interconnection between religion, culture, and healthcare choice in Malaysia.

6.1 From dissemination to integration: a fundamental reorientation

To address the limited knowledge of TCM and its regulation in Malaysia, public education using multilingual TCM materials such as English and Malay is needed. It is recommended to disseminate information through newspapers, radio, television, and various social media platforms about proper TCM concepts, practitioner registration requirements, and how TCM differs from other traditional medicines. This would improve understanding of TCM herbal composition, address misclassification with other medical systems, and enhance awareness of the relevant regulations.

To date, there have been 15 T&CM units set up in government hospitals. Among which, acupuncture and traditional Malay massage services are the treatment modalities offered across all the hospital.[29] However, patient utilization at these T&CM units remains limited due to lack of awareness and structural barriers. Patients are not allowed to seek T&CM treatment without referrals from Western medicine practitioners. Campaigns highlighting the availability of TCM services at government hospitals would raise public awareness and contribute to TCM's integration into the national healthcare system in the medium term.

Most importantly, a paradigm shift from one-way dissemination to genuine cultural integration is required to enhance TCM acceptance. This means that beyond raising public awareness, future work would benefit from having a deeper understanding of the local belief systems, values, and health perceptions that shape how engage with TCM. Demonstrating TCM's alignment with Islamic values, particularly through halal-compliant practices and dialogue with religious authorities, may help address religious concerns and support its cultural integration. Such measures require institutional support, inter-agency collaboration, and sufficient resources to be effectively implemented. Partnerships between public health agencies and halal-certified private TCM providers could expand access to the Malay populations without overwhelming public healthcare facilities, creating a more balanced and sustainable pathway for TCM integration. A more effective approach would move beyond merely "explaining" Chinese medicine to translating its essence into concepts compatible with local worldviews and religious frameworks.

6.2 Institutions as cultural translators and adapters

The role of TCM institutions, universities, and healthcare centers would also benefit from a paradigm shift. Instead of acting as mere health knowledge and healthcare service providers, they could play a more pivotal role by evolving into intercultural mediators, bridging scientific, cultural, and spiritual languages together. Lecturers could begin instilling cultural and religious sensitivity in students. From having an awareness when conducting physical examination, through to ensuring the prescribed medications meet the religious and cultural needs of patients, TCM practitioners in Malaysia could uphold the concept of patient-centeredness even more when dealing with Malay patients. Living in a diverse multicultural society, patients would also need to understand the sociocultural background where other patients come from instead of forcing other patients to adapt to their own needs. The institutions would need to analyze different community segments (age, education, religion) to design communication plans and treatment models that resonate with each group's cognitive and cultural expectations. Building capacity for multilingual and culturally sensitive practitioners would be central to this transformation.

6.3 Toward a dialogic halal certification framework

Halal certification and herbal product regulation represent both challenges and opportunities for TCM localization. The current registration for traditional Chinese herbal medicine products is lengthy, conducted purely from pharmaceutical perspective and lacks sufficient input from TCM content experts. While such a registration process may uphold scientific rigor and protect patient safety, it fails to safeguard the intellectual heritage of TCM. The separate certification process required for halal certification further exacerbates the time needed. Reforming this structure through collaborations among TCM professionals, religious councils, and regulatory agencies could produce a dialogic certification

framework—one that maintains scientific rigor while respecting traditional principles and religious values with a unified process. Such a human-centric model could serve as a prototype for culturally responsive health regulation in the region.

At present, although there are halal-certified Chinese herbal medicine products available in the market, most Malay participants in the survey were not aware of them. This is likely due to a combination of cultural mistrust and lack of communication channels to disseminate the information. Similar to the registered medical device database used by the Medical Device Authority, or the Quest 3+ registered product database used by the NPRA, a halal-certified database by JAKIM, made available for the access of the general public will build trust and break the communication barrier to disseminate such important information to Malay consumers.[30,31]

6.4 Building a Southeast Asian narrative of TCM modernization

Future TCM modernization in Malaysia could extend beyond a single cultural reference point to develop a scientific narrative rooted in the local culture, socio-economic values, and health concepts. This includes ensuring local TCM education is accessible to non-Chinese students, building trust in TCM among Malay communities using relatable languages, practices, and beliefs, fostering cross-cultural research collaborations, and producing evidence in forms that are meaningful and credible to local Malaysians. Through such actions, the value of TCM would be validated, leading to an authentic and meaningful localization of TCM and contributing to the local health ecosystem. As Southeast Asian countries share similar values and approaches to traditional medicine, these efforts may have broader relevance to the region, shaping a unique health experience that is well-integrated into local cultures and accepted by communities.

7 Conclusion

This study found that although TCM usage among the Malay respondents in UTC Shah Alam was relatively low, attitudes and behaviors remained positive, particularly toward Chinese herbal medicine and acupuncture. The combination of limited knowledge and positive attitudes suggests openness to future engagement of TCM, provided that issues of trust, regulation, and cultural compatibility are addressed. Financial status significantly influenced attitudes, while halal certification emerged as a critical determinant of acceptance, underscoring the importance of integrating cultural and religious considerations into local healthcare delivery. Promoting TCM in Malaysia will therefore benefit from concerted efforts among TCM institutions, Islamic authorities, healthcare providers and government agencies to move from one-way information dissemination to reciprocal learning and cultural integration. Rather than positioning TCM as an external or alternative system, emphasis would be better placed on building dialogue between medical traditions, fostering multilingual education, and strengthening partnerships among TCM institutions, Islamic authorities, and public health agencies. Short- and long-term actions may include developing Halal-certified herbal databases, establishing joint training programs for culturally competent practitioners, and enhancing accessibility to safe, evidence-based TCM services. In conclusion, the sustainable development of TCM in Malaysia depends on its ability to adapt—not only through regulatory or educational reforms but through deep cultural translation and social resonance. Continuous academic collaboration, cross-cultural dialogue, and respect for local traditions would enable TCM to become not merely an integrated component of Malaysia's multicultural health identity, but a model for how traditional knowledge systems contribute meaningfully to global health and intercultural understanding.

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Ethical approval

This research was approved by the IMU Joint Committee on Research and Ethics (IMU-JC) on October 19th 2023. Approved institutional review board number is 4.10/JCM-275/2023.

Author contributions

Tang Sin Wei and Wong Hon Foong guided the research study. Ahmad Mujahid Mazlan performed the research, data analysis and drafted the manuscript. Tang Sin Wei revised this manuscript and it was further corrected by Wong Hon Foong. All authors have read and agreed to the published version of the manuscript.

Conflicts of interest

Wong Hon Foong is a Youth Editorial Board member of *Chinese Medicine and Culture*. The article was subject to the journal's standard procedures, with peer review handled independently of this Youth Editorial Board member and his research groups.

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Traditional Chinese Medicine in Uganda: History, Present, and Future

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Abstract

In the context of globalization, traditional Chinese medicine (TCM) has transcended geographical boundaries to provide the world with Chinese philosophical principles and therapeutic methodologies, which have been welcomed by the people of the world. Similarly, Uganda's indigenous medical traditions embody profound ethnomedical knowledge, creating a robust foundation for cross-cultural exchanges in phytotherapy between the two nations. The introduction of TCM to Uganda started in the 1980s, facilitated by successive Chinese medical teams dispatched under the framework of Sino-African health cooperation, and has engendered a gradual yet sustained trajectory of acceptance and integration within local healthcare systems. Empirical evidence indicates that TCM's therapeutic efficacy, cultural adaptability, and cost-effectiveness have progressively contributed to its growing institutional recognition and community-level adoption across Uganda's diverse demographic groups since its initial dissemination. Therapeutic approaches such as acupuncture and massage, along with the remarkable efficacy of artemisinin in combating malaria, offer local populations more options for disease prevention and health maintenance. This paper examines the historical development and current practices of TCM in Uganda, aiming to provide insights and recommendations for addressing challenges related to infectious disease control, chronic disease management, and health resource accessibility in Africa and other underdeveloped regions. Furthermore, it proposes cross-cultural implementation strategies for integrating traditional medicine into the global health governance framework, thereby contributing to the construction of a global community of health.

Keywords: Uganda; Traditional Chinese medicine; The Silk Road; Acupuncture; Artemisinin; Forum on China-Africa Cooperation (FOCAC)

1 Introduction

The Republic of Uganda (commonly referred to as Uganda) is an inland developing country in East Africa. It is recognized by the United Nations as one of the least developed countries in the world, with a GDP per capita of 1,096 US dollars in 2022.[1] Historically, Uganda was ruled successively by the Bunyoro-Kitara Kingdom (Note 1) and the Buganda Kingdom (Note 2).[2] Bunyoro-Kitara Kingdom used to be one of the strongest and most affluent kingdoms in Central and East Africa between the 14th to 19th centuries. During this period, the region flourished with robust national strength and thriving international trade. Concurrently, this era corresponded with China's Ming dynasty (1368–1644), during which the Maritime Silk Road (Note 3) trade flourished. There were the historically renowned Zheng He's (郑和) (Note 4) (Fig. 1) voyages to the Western Oceans, when he reached the East African region.[3]

Currently, Uganda is one of the countries with the platform of the Forum on China-Africa Cooperation (FOCAC) (Note 5). The two countries have carried out a series of cooperation projects, promoting exchanges and cooperation in various fields such as the economy, culture, and medicine. Ugandan students have come to China to study at Chinese medical universities and obtain academic degrees in traditional Chinese medicine (TCM),[4] and are now practicing TCM in Uganda.[5] Furthermore, research on the dissemination and development of TCM in Uganda can provide empirical evidence for readers to objectively understand the role of traditional medicine in underdeveloped regions, explore its unique advantages, and clarify its distinctive characteristics as a healthcare resource. The following content discusses the dissemination and development of TCM in Uganda from historical, present, and future perspectives.

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Figure 1 A portrait of Zheng He (郑和) (Source with permission from: the digital resource "Database of Images of Chinese Figures Through the Ages" of Zhejiang Library)

2 The dissemination of TCM in Uganda during the Maritime Silk Road period

Uganda is an East African country. Material exchanges between China and East Africa can be traced back to the Tang dynasty (618–907). By the time of the Song dynasty (960–1279), the imperial court placed great emphasis on foreign trade, with foreign trade ports such as Guangzhou and Quanzhou recording the presence of merchants from East Africa.[6] According to *Song Hui Yao Ji Gao* (《宋会要辑稿》 *Draft for the Collected Statutes of the Song Dynasty*),[7] more than 60 kinds of Chinese medicinal materials, such as *Zhu Sha* (朱砂 Cinnabaris), *Niu Huang* (牛黄 Bovis Calculus), *Ren Shen* (人参 Ginseng Radix et Rhizoma), *Fu Ling* (茯苓 Poria), *Hu Jiao* (胡椒 Piperis Fructus), *Xiao* (硝 Nitre) and so on, were transported to East Africa through the *Shi Bo Si* (市舶司 customs in the Song dynasty) with the help of Arabian people.[8] During the Yuan dynasty, the Chinese navigator Wang Dayuan (汪大渊) visited Africa and described Zanzibar (now part of Tanzania, neighboring country of Uganda) in detail in his book *Dao Yi Zhi Lue* (《岛夷志略》 *Records of Overseas Islands*).[9] By the Ming dynasty, TCM was exported to Africa by ocean route. From 1405 to 1433, Zheng He made seven voyages to the Western oceans and reached as far as the eastern coast of Africa, which is recorded in *Ming Shi Zheng He Zhuan* (《明史·郑和传》 *The History of the Ming Dynasty: Biography of Zheng He*). During his seven voyages, Zheng He reached coastal regions near Uganda, such as Mu Gu Du Shu (木骨都束 Mogadishu), Ma Lin (麻林 Malindi).[10] According to historical records, Mu Gu Du Shu corresponds to Mogadishu, the present-day capital of Somalia, while Ma Lin corresponds to Malindi, a significant coastal city situated in the southeastern coastal region of Kenya. During the visits to African countries, Zheng He's missions shared China's advanced scientific and medical knowledge on seeking medical treatment for various ailments and applying acupuncture techniques. His missions boasted a team of exceptionally proficient TCM doctors and carried a vast array of Chinese herbal medicines on board. With these resources at their disposal, they not only treated the crew members but also provided medical assistance to local patients during their visits to different places.[11] According to *Zheng He Jia Pu Kao Shi* (《郑和家谱考释》 *The Textual Research and Interpretation of Zheng He's Genealogy*) (Fig. 2), Zheng He did not only carry Chinese medicinal materials, exemplified by *She Xiang* (麝香 Moschus), but also was accompanied by skilled Chinese physicians. The original text recorded that:

> "随勅奉差诸官员名: ……医官医士一百八十员。
> Name list of the officials dispatched under imperial edict: ... one hundred and eighty medical officers and physicians." (Fig. 3)[12]

To date, there is no documented evidence demonstrating that China and Uganda established direct trade links during the Maritime Silk Road era. Archaeologists have

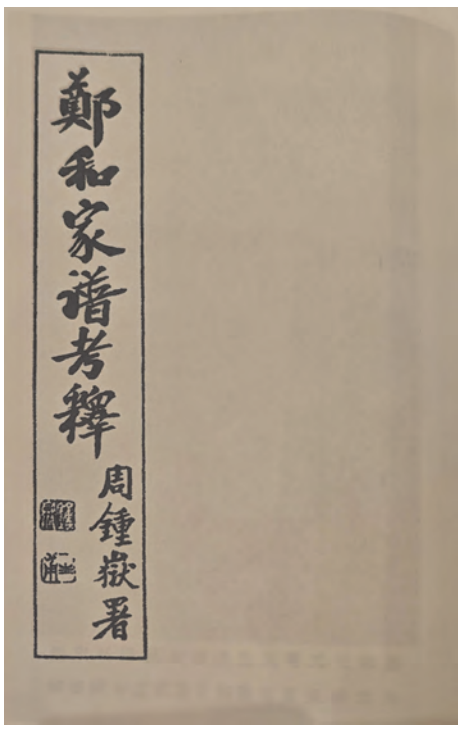

Figure 2 Title page of *Zheng He Jia Pu Kao Shi* (《郑和家谱考释》 *The Textual Research and Interpretation of Zheng He's Genealogy*) (Source with permission from: Zhejiang Library)

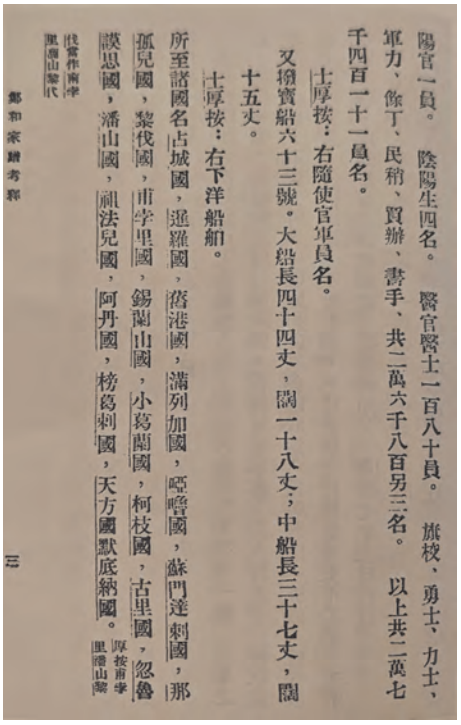
陽官一員。陰陽生四名。醫官醫士一百八十員。旅校、勇士、力士、
軍力、餘丁、民稍、買辦、書手、共二萬六千八百另三名。以上共二萬七
千四百一十一員名。
士厚按：右隨使官軍員名。
又領寶船六十三號。大船長四十四丈，闊一十八丈；中船長三十七丈，闊
十五丈。
士厚按：右下洋船舶。
所至諸國名占城國，暹羅國，舊港國，滿剌加國，哑嚕國，蘇門達剌國，那
孤兒國，黎伐國，甘字里國，錫蘭山國，小葛蘭國，柯枝國，古里國，忽魯
謨斯國，溜山國，祖法兒國，阿丹國，榜葛剌國，天方國默底納國。
三

Figure 3 Page three of *Zheng He Jia Pu Kao Shi* (Source with permission from: Zhejiang Library)

found small amounts of glass beads and sea shells at the Ntusi site in Uganda, near Kampala today, suggesting trade links with the coastal regions. Some scholars argued that the East African coastal regions and adjacent offshore hinterlands were not entirely isolated but maintained interactive engagements, as evidenced by the participation of inland populations in diverse forms of trade between coastal and near-shore hinterland areas.[13] It could be concluded that Ugandans were likely exposed to medical exchanges along the East African coast. However, due to various reasons, Chinese herbal medicine has not been widely disseminated in Uganda.

3 The current development of TCM in Uganda

Uganda gained sovereignty in 1962, yet the nascent state faced multifaceted challenges including a severely deteriorated healthcare infrastructure, an acute shortage of medical professionals, and the persistent prevalence of endemic diseases.[14] In the same year, China and Uganda established diplomatic relations. Within the broader background of Sino-African health diplomacy, the task of deploying medical teams to Uganda was assigned.[15] In 1983, the first medical team from Yunnan was officially dispatched to Jinja Regional Referral Hospital, located in Jinja city, eastern Uganda. The team consisted of 12 members, including nine medical specialists spanning eight clinical disciplines and acupuncture, as well as three assistants.[16] This is the first time that TCM was officially introduced to the country.

For more than 40 years, Yunnan province (云南省) has continuously dispatched 24 medical teams to Uganda, totaling 227 medical experts, and has cumulatively treated over 100,000 local patients.[17] Those highly skilled and ethical Chinese doctors bring to Ugandans not only advanced Western medical techniques but also the wonders of TCM.[16]

3.1 The dissemination channels of TCM in Uganda

The dissemination of TCM in Uganda has been primarily facilitated through two distinct channels, namely via Chinese private clinics in Uganda and hospitals where Chinese medical teams providing aid to Uganda are stationed. The specific information is summarized and presented (Table 1).

First, privately run TCM clinics have emerged, mainly established by Chinese nationals.[18] Private TCM clinics in Uganda are known to be more prevalent in Kampala, the nation's capital city. These clinics provide basic Chinese medical services such as acupuncture therapy, massage, cupping, herbal medicine, etc., and also sell medicinal tablets made from Chinese herbs.

Secondly, the propagation and development of TCM in the region has also been facilitated by the collaboration between the governments of China and Uganda. Since 1983, every medical team dispatched to the region has included TCM practitioners, a tradition that began with acupuncturist Zhou Youmin (周幼民) who joined the inaugural mission (Fig. 4).[16] In Uganda, both Jinja Regional Referral Hospital (in Jinja city) and China-Uganda Friendship Hospital, Naguru (in Kampala) have served as sustainable hubs for TCM dissemination. These clinics deliver TCM diagnostic services, therapeutic interventions, and holistic health maintenance practices to local populations, reflecting an integrated model of cross-cultural healthcare delivery. Furthermore, the TCM practitioners embedded in the medical team regularly travel to the underserved rural areas in Uganda, providing voluntary medical consultations and delivering lectures (Fig. 5).[19]

The team provided free medical services to Ugandans and further enhanced the Ugandan people's knowledge and understanding of TCM.[20] Through the exquisite medical skills of the TCM doctors and the proven therapeutic efficacy of TCM in treating common diseases in Uganda, treatments such as acupuncture, massage and cupping therapy have gradually gained acceptance among the Ugandan populace.

3.2 Treatment and efficacy of acupuncture in Uganda

Uganda has a predominant portion of its population engaged in labor-intensive agricultural practices. These activities frequently necessitate prolonged stooped postures during cultivation, harvesting, and other fieldwork

Table 1 TCM hospitals and clinics in Uganda

Name	City	Scale	TCM Treatments
Natural Chinese Herbal & Acupuncture Clinic	Kampala (Kamwokya/Kira Road)	Private clinic	Herbal medicine, acupuncture, consultations
Chinese Medical Center	Kampala (Nsambya Road)	Private clinic/medical center	Primary care with Chinese practitioners
Fukang Health Care	Kampala (Mirage Plaza, Kitintale)	Private herbal supplier/clinic	Chinese herbal medicine sales and consultations, NDA-approved products
Beijing Medical Center	Kampala (Barnabas Road)	Private medical center	General medical services
Dr. Eva Lee—Chinese Medicine	Kampala	Private practitioner	Acupuncture and TCM consultations
CORAEON / Local acupuncture therapists	Kampala	Private practice/wellness center	Acupuncture for pain, stress, meridian balancing
Mobile Chinese medical teams	Various districts	Visiting outreach teams	Short-term free clinics, acupuncture demos, herbal treatment outreach
China-Uganda Friendship Hospital	Kampala	Hospital (large, government/ bilateral project)	General hospital services with Chinese-Uganda teams, Acupuncture ward, inpatient care, outreach
Jinja Hospital (and district hospitals)	Jinja (and other districts)	Public hospital(s)	Acupuncture services and training, outreach
Global Acupuncture Project (training sites)	Kampala / Uganda (various)	NGO training program	Integration of acupuncture in local health facilities

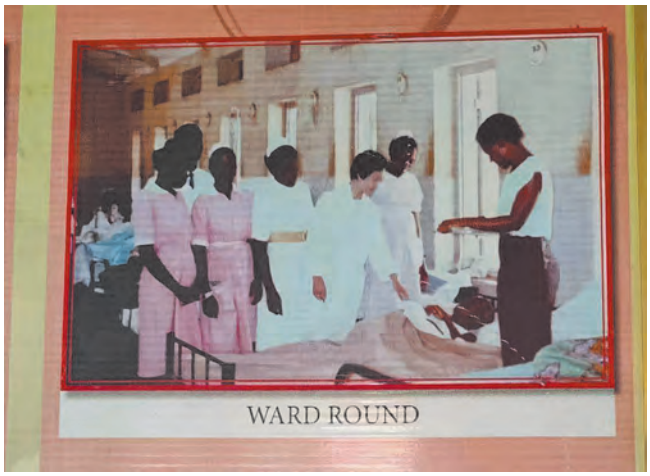

Figure 4 The fourth batch of Chinese medical team working at Jinja Regional Referral Hospital between 1989 and 1991 (source with permission from: photo of the exhibition room of the Chinese medical team aiding Uganda, located in Yunnan province)

tasks. The humid climate and strenuous agricultural labor in Uganda exacerbate musculoskeletal disorders, with lumbar pain, leg pain, and arthralgia being frequently encountered clinical presentations.[21] The introduction of Chinese acupuncture has demonstrated therapeutic benefits in addressing these conditions. The application of acupuncture at specific acupoints on patients has been shown to effectively reduce swelling and pain, enhance blood circulation to resolve blood stasis, and improve joint lubrication. This therapeutic modality demonstrates significant efficacy in alleviating conditions such as back and leg pain, with its clinical benefits supported by both traditional practice and emerging evidence in integrative medicine.[22] Acupuncture therapy demonstrates the capacity to minimize or eliminate reliance on pharmacological analgesics, thereby reducing or obviating associated multi-organ toxicities.[23]

Figure 5 Free medical consultation and treatment day hosted by Sinohydro and Chinese medical team [source with permission from: Report on the development of Chinese enterprises in Uganda (2023–2024)[1]]

Archival records from the second Chinese medical team in Uganda (housed in the Yunnan Provincial Archives) document that acupuncture practitioners maintained five to six hours daily clinical sessions, providing sustained patient care. A well-documented case details the experience of the head of Uganda's Ministry of Agriculture, who had suffered from chronic lumbar pain requiring crutch assistance for mobility. Following a course of acupuncture therapy, he regained full ambulatory capacity.[16] Subsequently, a substantial number of patients traveled specifically to the medical team to access therapeutic interventions, reflecting the growing recognition of acupuncture's clinical value within local communities.

3.3 Adoption and efficacy of Chinese artemisinin in Uganda

Beyond acupuncture, artemisinin has become a cornerstone of malaria treatment in Uganda. Uganda lies in a tropical disease-endemic zone where infectious pathogens account for over half (54%) of the national health burden, with malaria emerging as the single most critical public health threat in the region.[2] The prevalence of infectious diseases such as malaria and the scarcity of public medical resources have significantly endangered the health of Uganda's population. The Chinese-developed artemisinin-based anti-malarial medicine, Dihydroartemisinin and Piperaquine Phosphate tablets (科泰复), has proven to be highly efficacious in the fight against malaria, saving innumerable lives in Uganda.[24] Since 2006, China has consistently supplied anti-malarial medications to Uganda, with annual supply volumes steadily increasing.[25] In November 2006, shortly after the FOCAC, China dispatched five anti-malaria experts to Uganda to train 48 local healthcare professionals.[26] In October 2007, a delegation of 20 Ugandan professionals from government agencies, hospitals, and disease control centers traveled to Wuxi city (无锡市) of China to participate in specialized training programs on malaria prevention and control.[26] In 2008, the unveiling ceremony of the China-aided Malaria Control and Prevention Center in Uganda, along with donation ceremony of medical supplies, was held at Mulago National Referral Hospital in Kampala.[27] In 2011, the Malaria Control Office under the Ugandan Ministry of Health (MOH) released a revised Uganda National Malaria Control policy, designating Chinese artesunate (青蒿琥酯) as the first-line treatment for severe malaria, thus replacing quinine (奎宁) which had been used for decades.[28] In February 2024, China donated about 500,000 packs and doses of anti-malaria medicines worth 1.1 million U.S. dollars to Uganda.[29] In contrast to 2007, when Uganda's MOH disclosed that malaria claimed 320 daily lives,[2] the World Health Organization announced in 2023 that the country recorded nearly 12 million malaria cases and 2,793 deaths.[30] The aforementioned data demonstrate that TCM has played a pivotal role in supporting Uganda's anti-malaria efforts.

3.4 Trade of TCM between China and Uganda

Data showed that the Chinese medicinal products exported to Uganda mainly include cooling oil, artemisinin medicinal products and other Chinese patent medicines. In 2023, China exported $45 worth of cooling oil, $25,536 in proprietary Chinese medicines, and over $6.48 million in artemisinin medicines to Uganda. In 2024, artemisinin medicines exported to Uganda exceeded $8.71 million, with a leading proportion in the Chinese medicinal products trade with Uganda.[31]

The National Drug Authority (NDA) of Uganda serves as the country's pharmaceutical regulatory body. All medicinal products sold in Uganda, including Chinese herbal medicine products, must first obtain registration and approval from the NDA to ensure their safety and efficacy before entering the national market.[32] Currently, the Chinese herbal medicine products sold in Uganda's pharmacies can be broadly categorized into three types. The first category consists of patented TCM products, exemplified by *Lian Hua Qing Wen* Capsule (莲花清瘟胶囊) produced by Yiling Pharmaceutical Co., Ltd. (which has obtained NDA approval and marketing authorization),[33] and KPC Pharmaceuticals' artemisinin-based anti-malarial medicines.[34] The second category comprises of Chinese herbs, such as *Dong Chong Xia Cao* (冬虫夏草 Cordyceps), *Ren Shen* and *Gou Qi* (枸杞 Lycii Fructus).[35] The third category consists of Chinese healthcare products, such as spirulina capsules and lipid-lowering teas.[35]

3.5 The dissemination of TCM culture in Uganda

With the inclusion of acupuncture and moxibustion in UNESCO's Intangible Cultural Heritage List,[36] the international recognition of TCM has been significantly enhanced, which facilitates its dissemination in Uganda. The propagation of TCM culture in Uganda is primarily promoted through cultural exchange activities organized by institutions such as the Chinese Embassy in Uganda and the Confucius Institute at Makerere University, alongside other relevant departments and organizations.[37] In 2017, during the third-anniversary celebration of the Confucius Institute at Makerere University, Ugandan students performed Tai Chi Fan (a form of traditional Chinese martial arts), which indirectly demonstrated the dissemination of Chinese healthcare practices in Uganda (Fig. 6).

In addition, academic exchanges between Sino-African research institutions have enhanced Ugandans' understanding of TCM culture. For instance, in April 2021, the China-Africa Institute hosted a forum themed "Prevention and Control of COVID-19 by Chinese and African Traditional Medicine", which was attended by scholars from China, Uganda, and other African nations.[38]

Figure 6 The performance of Tai Chi Fan at the Confucius Institute of Makerere University (source with permission from: http://ug.china-embassy.gov.cn/chn/zwgx/rwwl/201711/t20171127_7269493.htm)

3.6 The recognition and utilization of TCM among the Ugandans

To obtain a more genuine insight into Ugandan citizens' perception and utilization of TCM, the author conducted a questionnaire survey among residents of Kampala and three other central-western cities. A total of 163 questionnaires were collected, with 132 valid responses. The survey results revealed that 116 respondents (87.9% of the total) heard of TCM, while 90 respondents (68.2%) had received TCM treatment. The questionnaire primarily focused on TCM treatment and services utilized by Ugandans, types of diseases treated, treatment duration, and therapeutic outcomes. Below is a detailed analysis of the 90 respondents who had received TCM treatment, comprising 36 males and 54 females. The specific results are presented (Table 2).

This survey reveals that TCM provides diverse healthcare options for local populations. TCM has demonstrated effectiveness in treating common illnesses such as diarrhea and influenza, as well as infectious diseases like malaria. Among TCM treatment services, acupuncture, herbal medicine, and skincare enjoy high acceptance among Ugandans. Regarding the age distribution of TCM recipients, 73.3% were young and middle-aged adults, which lays the foundation for disseminating TCM cuture and practices in Uganda.

4 Future development of TCM in Uganda

In the context of the Belt and Road Initiative (BRI) and FOCAC, the connections between China and Uganda have grown increasingly close, particularly in areas such as herbal medicine conservation and cooperation, standardized regulation of TCM, and talent cultivation. There is significant potential for further collaboration in these domains, which aligns with the strategic development needs of both nations' healthcare systems.

4.1 Cooperation in the protection and development of herbal medicine

Under the framework of FOCAC, collaboration between China and African nations in the herbal

Table 2 Recognition and utilization of TCM among the Ugandan population

Age	Types of Disease	TCM Treatment	Average Treatment Duration	Treatment Effect
0–18	Skin disease (acne), cold, flu, mental disorder and body pain	Herbal medicine, acupuncture, skincare and massage	1 week	Significant: 8.3% Moderate:75% Slight:16.7% None:0% Unsure:0%
19–30	Malaria, diarrhoea, eczema, cold, body pain and fungal infections	Skincare, herbal medicine, acupuncture and moxibustion	1.16 week	Significant:18.9% Moderate:70.3% Slight:8.1% None:0% Unsure:2.7%
31–45	Malaria, diarrhoea, rosacea and body pain	Massage, acupuncture, herbal medicine and skincare	1.55 week	Significant:20.7% Moderate:62.1% Slight:13.8% None:3.4% Unsure:0%
46–60	Infectious diseases, body pain, digestive disease and hormonal issues	Herbal medicine, massage and acupuncture	1.5 week	Significant:25% Moderate:62.5% Slight:12.5% None:0% Unsure:0%
> 60	Fungal infection, urticaria and body pain	Herbal medicine and massage	1.625 week	Significant:50% Moderate:25% Slight:0% None:25% Unsure:0%

medicine sector is poised for significant advancement. "The China-Africa Cooperation Vision 2035 (中非合作2035年愿景)" (Fig. 7) explicitly states China's commitment to supporting Africa's healthcare development, with particular emphasis on advancing traditional medicine and enhancing pharmaceutical accessibility and affordability.[39] The *National Pharmaceutical Services Strategic Plan 2020/21–2024/25*,[40] issued by Uganda's MOH in 2021 specifically emphasizes expanding local pharmaceutical manufacturing and fostering innovation in herbal medicine development.

A survey conducted in the Katikekile county of Uganda revealed that 68% of adults rely on herbal remedies for healthcare.[41] This indicates that herbal remedies have a significant market presence in Uganda. However, the integration of herbal medicine into Uganda's healthcare sector remains limited, primarily because the pharmacological profiles of numerous indigenous herbs have not been adequately studied, and there is a lack of rigorous scientific evidence regarding their bioactive compounds and clinical efficacy.[42] China's herbal medicine research has established a comprehensive system and technical methodologies, offering valuable practical experience for Uganda's herbal research and development. Furthermore, China could provide technical assistance in pharmacovigilance systems and Good Agricultural and Collection Practices (GACP) could significantly enhance Uganda's capacity for sustainable ethnobotanical research, thereby addressing critical gaps in medicinal plant documentation, quality control, and commercialization pathways.[43]


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Figure 7 The China-Africa Cooperation Vision 2035 (source with permission from: https://sl.mofcom.gov.cn/zshz/art/2021/art_2a5fc-65585894b7e95c27135289d1545.html)

4.2 Regulatory framework for TCM in Uganda: challenges and opportunities

The global dissemination of TCM is closely tied to the establishment of comprehensive legal frameworks in host countries. For instance, South Africa officially recognized TCM within its national healthcare system in 2011, catalyzing rapid institutional and clinical development.[44] In the past, TCM therapies functioned primarily as a form of traditional and complementary medicine within Uganda's private healthcare sector.[45] However, Ugandan law contains no provisions regulating TCM practices, meaning TCM lacks legal recognition in the country.

According to the *Traditional and Complementary Medicine Act 2019*, the Ugandan government aims to establish a National Council for Traditional and Complementary Medicine Practitioners to control and regulate the practice of traditional and complementary medicine, including the registration and licensing of practitioners.[46] Although the MOH has not yet fully implemented the act, it will to some extent provide a legal basis for the development of Chinese herbal medicine in Uganda. Additionally, Uganda could learn from legislative experiences of different countries regarding TCM through collaboration with Chinese medical teams and health authorities from other nations.

4.3 Cooperation in the training of TCM talents

Given the shortage of local healthcare professionals in Uganda, China has prioritized the promotion of capacity-building programs for Ugandan medical workers. These initiatives include integrating TCM courses into educational curricula and implementing specialized training projects.[47] TCM education in Uganda primarily comprises two main approaches. The first is the short-term TCM-related training programs and scholarship schemes facilitated by China, enabling Ugandan students to pursue TCM-related disciplines at accredited Chinese medical institutions. Since 2016, more than 1,200 Ugandans have attended training courses and seminars held in China. Over the past few years, China has sponsored over 250 Ugandan students through scholarship programs and other initiatives, with the majority obtaining academic qualifications.[48] Among them, a remarkable number of Ugandan students have been captivated by TCM and have chosen to enroll in TCM universities located in China. Take Zhejiang Chinese Medical University (浙江中医药大学, ZCMU) as an example: according to the website of the Academic Affairs Office of ZCMU, ZCMU has recruited a total of 36 Ugandan

students from 2020 to 2024. The data in the table below indicates an increasing trend in the number of Ugandan students, suggesting that majors related to TCM are becoming increasingly recognized and attractive to students from Uganda (Fig. 8).

Secondly, TCM practitioners in medical teams can impart basic acupuncture knowledge and skills to local people. Jinja Regional Referral Hospital gained national recognition as the country's second-largest teaching hospital following the arrival of the inaugural Chinese medical team. An earlier case occurred in 2006, Rose Kawuma and Jesca Namugoya (two nurses) acquired acupuncture competencies through training with the rotating Chinese medical teams stationed at this hospital (Fig. 9). Subsequently, they accumulated extensive practical experience, applying acupuncture therapy to treat cervical and lumbar pain, as well as other conditions, among local elderly patients (Fig. 10).[5]

5 Conclusion

TCM and African traditional medicine are representatives of the splendid cultures of China and Africa, and they are also important components of the cultural exchanges and mutual learning between the two civilizations. On the 60th FOCAC anniversary, it was noted that Uganda and China, have made remarkable achievements. TCM culture, a crystallization of millennia of Chinese wisdom, has traversed vast distances from the heart of China to Uganda, serving as a vibrant testament to the cultural exchange and mutual learning between the two nations. This distinctive "gift" is infusing new vitality into the advancement of Uganda's medical sector and penning a fresh chapter in the amicable relations between China and Uganda. Through this study, we can gain insights into the distinctive strengths of TCM in underdeveloped regions, with the goal of extending its benefits and accessibility to a broader range of countries and regions worldwide.

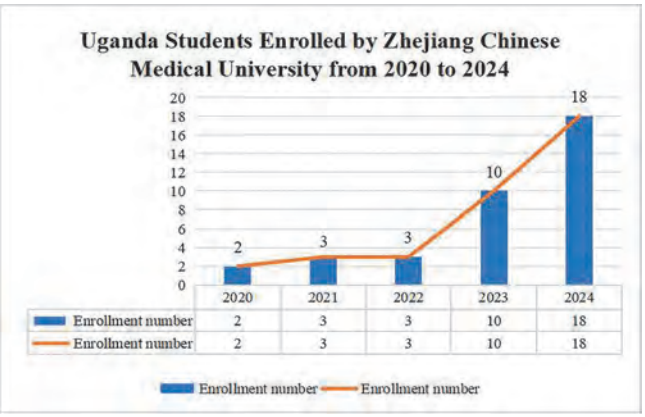

Figure 8 Uganda students enrolled by Zhejiang Chinese Medical University from 2020 to 2024 (source with permission from: picture made by the authors)

Figure 9 Cong Linhai (R), head of the18th Chinese medical team and nurse Rose Kawuma (L) and Jesca Namugoya pose for a group photo at Jinja Regional Referral Hospital, August 14th, 2018 (source with permission from: Xinhua News Agency; photo taken by Xinhua News Agency reporter Zhang Gaiping)

Figure 10 Chinese acupuncturist Li Xiaobin (L) demonstrates acupuncture therapy to trainee Daisy Naluyange at China-Uganda Friendship Hospital, Naguru, August 19th, 2022 (source with permission from: Xinhua News Agency; photo taken by Xinhua News Agency reporter Zhang Gaiping)

Notes

1. The Bunyoro-Kitara Kingdom was one of the most powerful and prosperous kingdoms in Central and East Africa from the 14th to the 19th century, which formerly spanned much of present-day Uganda. Strategically positioned, Bunyoro-Kitara controlled key trade routes via Lake Victoria, granting it direct access to Indian Ocean coastal trade networks. This advantageous geography facilitated extensive commerce with neighboring regions and merchants from across the globe, contributing to its economic and political dominance.
2. Buganda was a Bantu Kingdom that developed within the territory of Uganda, with its ruling area covering the central region of Uganda and its capital Kampala. Buganda developed into one of the largest and most powerful countries in East Africa in the 18th and 19th centuries.
3. The Maritime Silk Road connected Southeast Asia, East Asia, the Indian subcontinent, the Arabian

Peninsula, East Africa and Europe. It began in the 2nd century BC and flourished until the 15th century AD. From the 10th to the 15th century AD, China began to build merchant ships and sail along this route. This route through the Indian-Western Pacific (Southeast Asia and the Indian Ocean) facilitated various types of goods exchanges between different countries and regions at that time and effectively promoted trade between China and other countries.

4. Zheng He was a Chinese navigator and diplomat during the early Ming dynasty (1368–1644). Between 1405 and 1433, Zheng commanded seven voyages across Asia under the commission of Emperor Yongle (永乐) and the succeeding Emperor Xuande (宣德) (1426–1435). Zheng He's fleets covered more than 30 countries and regions in Asia and Africa, reaching as far as the Red Sea coast and the east coast of Africa.

5. FOCAC is the abbreviation of the Forum on China-Africa Cooperation, which was established in 2000. Members include China, 53 African countries that have established diplomatic relations with China, and the African Union Commission. FOCAC has become an important platform for China and Africa to enhance political mutual trust, economic cooperation and cultural exchanges.

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Ethical approval

This article does not contain any studies with human or animal subjects performed by any of the authors.

Author contributions

LIN Jie guided the research, rewrote, reviewed, and edited the manuscript. HAN Xue did the research, and wrote the draft. Namusiitwa Resty participated in data collecting and processing. All authors have read and agreed to the published version of the manuscript.

Conflicts of interest

The authors declare no financial or other conflicts of interest.

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An Exploration of Dissemination and Exchanges between Ancient Traditional Chinese and Vietnamese Medicine

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Abstract

China and Vietnam are geographically connected, and Vietnam has been deeply influenced by Chinese culture. The development of Vietnam's ancient traditional medicine was profoundly shaped by China. This study aims to analyze the exchanges of traditional medicine between China and Vietnam from the Qin and Han dynasties to the Ming and Qing dynasties. Using a documentary analysis method, it conducts an extensive review of journals, ancient books and other materials related to Sino-Vietnamese traditional medical interactions. It reveals historical exchanges and interactions between ancient China and Vietnam in areas such as medicinal materials, medical practitioners, and medical books. These interactions enabled Vietnam to form a medical system that is inherently connected to Chinese medicine yet distinct in its own right. By doing so, this research enhances our understanding of the relationship between Chinese and Vietnamese medicine—one of shared origins with divergent developments—and provides a historical foundation for the inheritance and international exchange of traditional medicine today.

Keywords: Traditional medical exchange; China and Vietnam; Ancient medical books; Medical practitioners

1 Introduction

As early as the Qin and Han dynasties (秦汉时期), the traditional medicine of the two countries blended with each other. Traditional Vietnamese medicine, known as "Eastern medicine", "Vietnamese ethnic medicine" or "ancient Vietnamese medicine", has a long history of thousands of years. After France ruled Vietnam in the late 19th century, since China and Vietnam were "the East" relative to the "West", traditional medicine was called "Eastern medicine" to distinguish it from modern medicine in the West. In the long historical development, Vietnamese people formed their own medical system, which has much in common with traditional Chinese medicine (TCM) from theory to technology, and is still in existence and use today.[1]

Since the mid-20th century, several scholars have conducted research on the exchanges of traditional medicine between China and Vietnam. Domestically, researchers such as Feng Hanyong (冯汉镛) and Feng Lijun (冯立军) have focused on the close historical ties between the two countries, examining Sino-Vietnamese medical interactions from the perspective of medical dissemination. Scholars like Xiao Yongzhi (肖永芝) have approached the topic through Vietnamese medical books, elucidating the transmission of Chinese medical works and ideas in Vietnam. Internationally, scholar Mayanagi Makoto (真柳诚) conducted field research in Vietnamese libraries and the Vietnamese Han-Nôm Research Institute (越南汉喃研究院), summarizing the characteristics and trends of the ancient medical texts that still exist in Vietnam. Currently, research on Vietnamese medical books has primarily focused on textual analysis, without placing them in the historical context of ancient Sino-Vietnamese medical exchanges. This study will conduct a comprehensive analysis of the research on Vietnamese medical books and the historical materials related to Sino-Vietnamese traditional medical exchanges, linking textual research with historical analysis, and providing new evidence to deepen the understanding of the "shared origins and divergent developments" of the traditional medicine of the two countries.

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2 Overview of ancient Sino-Vietnamese relations

From a geographical perspective, Vietnam is a close neighbor to China, connected by mountains and rivers. Vietnam shares a border of over 1,000 kilometers with Guangxi (广西) and Yunnan (云南) provinces through its seven provinces, including Guangning (广宁) and Hejiang (河江). The geographic proximity has naturally facilitated exchanges between the two countries throughout various periods. As a neighboring country of China, Vietnam has been influenced by traditional Chinese culture since ancient times, and the influence has been more and more significant with the establishment and development of China's feudal dynasties. The language used in ancient Vietnam, its customs and architectural style, or its medicine all showed a strong Chinese flavor.

In a long historical period, Vietnam has integrated various aspects of Chinese culture and governance. Among all of the countries in Southeast Asia, Vietnam has been influenced by ancient Chinese culture the most.[2] As early as 214 BC, the first emperor of Qin dynasty (秦朝) established the prefectures of Nanhai (南海郡), Guilin (桂林郡) and Xiangjun (象郡), and incorporated the northern and central areas of today's Vietnam into Xiang prefecture, which started "the Period of Prefecture and County (郡县时期)" in Vietnamese history.[3] At the turn of the Qin and Han dynasties, Zhao Tuo (赵陀) established *Nan Yue Guo* (南越国 *South Yue Country*) and the two prefectures of Jiaozhi (交趾) and Jiuzhen (九真). Emperor Wu of Han dynasty (汉武帝) put down a rebellion of South Yue and divided it into nine prefectures, of which Jiaozhi, Jiuzhen and Rinan (日南) prefectures were all within the territory of the present Democratic Republic of Vietnam. Since then, the advanced culture, production technology and medical theories of the central plains have been continuously introduced into Vietnam, promoting the local economy and social progress. In the Sui and Tang dynasties (隋唐时期), the Annan (安南) protectorate was set up in Vietnam, with ten prefectures under it. Schools were established, and the legal system and imperial examination system of the Tang dynasty were implemented. At this time, Chinese characters became the official script of Vietnam, which was used for writing, education and literary creation, and the introduction of the imperial examination system also enabled the Vietnamese scholars to study the classics of Confucianism.[4] In the early Song dynasty (宋朝), Annan broke away from China and established the Kingdom of Daqu Yue (大瞿越国). The Dinh dynasty (丁朝, 968–980), the first autonomous feudal king in the history of Vietnam, was established by the Dinh leaders (丁部领), ending the Period of Prefectures and Counties (郡县制) and becoming a vassal of China.[5] After its independence, the State of Annan still followed the Chinese system of laws and regulations. The official system of Annan was similar to that of China, with six ministries, six offices and six departments in the central government, as well as the Censorate, *Tai Yi Yuan* (太医院 the Imperial Institute of Medicine), the National History Academy, and the Magistrate's Office, etc.[6] The local administration has the levels of province, prefecture, district and county, and the rank of officials and costumes were modeled after those of the Tang and Song dynasties. In Vietnam, the criminal documents issued by the Li dynasty (李朝, 1010–1225) and the criminal laws determined by the Chen dynasty were based on *Tang Lyv Shu Yi* (《唐律疏义》*Tang Code*). In all the dynasties of Annan, Confucianism was the basis of governing. The Li dynasty built Confucian temples. The Chen dynasty (陈朝, 1225–1400) founded a national college to teach *Si Shu Wu Jing* (四书五经 four books and five classics) and to rule the country with Confucianism, honoring Confucius as the "first teacher". The Li dynasty (黎朝, 1428–1788) took *Si Shu Da Quan* (《四书大全》*Complete Commentary on the Four Books*) as the content of the imperial examination.[7] During the Ruan dynasty (阮朝, 1802–1945), Chinese characters were still the official script, and official documents on histories such as *Da Nan Shi Lu* (《大南实录》*The Veritable Records of Vietnam*), and codes of law were written in Chinese. The Confucian classics were printed and distributed throughout the country.[4] At the middle of the 19th century, Vietnam became a colony of France. For more than 2,000 years, Vietnam almost transplanted and copied Chinese culture. Despite the efforts of the later French colonists, Chinese culture has remained in the blood of the Vietnamese people and has been integrated into all aspects of Vietnam's politics, economy, culture and society.[6] To this day, the distinctive "Chinese imprint" can still be found in Vietnam's language, customs, arts and monuments.

Chinese characters and language have been used in Vietnam for a long time. Since the implementation of the prefecture and county system in the Qin dynasty, a large number of immigrants from the central plains and Han officials entered Vietnam, and the long-term cultural exchange led to the absorption of many Chinese characters into the Vietnamese language, and the Vietnamese people also created the "Nan characters" based on the Chinese characters. According to linguists, more than 50% of modern Vietnamese characters were borrowed from Chinese.[4] Since the Vietnamese language belonged to the Sino-Tibetan language family (汉藏语系) and there were a large number of Chinese loanwords, it was suitable to use Chinese characters. Therefore, since the Qin and Han dynasties, Chinese characters had been the official and commonly used characters in Vietnam, called "Confucian characters". Until 1918, in the French colonial period when the abolition of Chinese characters was announced, Vietnam had used Chinese characters more than two thousand years. It was in this historical, social and cultural context that Vietnam's traditional

medical books came into being. To this day, distinct "Chinese traces" can still be found in aspects such as the language, customs, arts, and historical sites of Vietnam.

3 The History of the Intercommunication of herbs

There is a long history of medicine exchange between China and Vietnam, and Chinese medicinal materials have been introduced into the country through non-governmental trade and gift return from the government.[8] In the Tang dynasty, with the increasingly developed land and sea transportation, the medical trade between China and Vietnam was frequent. Annan "learned to use Lingbei (岭北) tea and medicine". At that time, the Tang government adopted open and inclusive policies toward merchants engaged in long-distance trade, transporting medicines, tea, and other goods to Annan while bringing back local products such as rhinoceros horns, hawksbill turtles, and pearls to China. As stated in *Jiu Tang Shu* (《旧唐书》*Old History of the Tang Dynasty*): "Trade should be promoted, and exchanges should not be prohibited (诸道一任兴贩，不得禁止往来)".[9] When the governments of the Song and Yuan dynasties accepted Vietnamese tributes, they also gave in return a large number of gifts to Vietnam, medicine included frequently. For instance, in the fourth year of the Yuan dynasty (1267), "Yuan gives jade belts, medicine, saddles and other things (元赐光易玉带、药饵、鞍髻等物)", and in the sixth year of the Yuan dynasty (1269), "give coins, silk and medicine in return to thank Vietnam (又具表纳贡，别奉表谢赐西锦、币帛、药物)".[10] During the Song and Yuan dynasties, a steady stream of Fujian (福建) merchants sailed to Jiaozhi. These merchant ships brought medicine, cloth and silk from China to be exchanged for Vietnamese pearls and jewelry.[11] In the Song dynasty, the government once opened two trade fairs in Qinzhou (钦州) and Yongping Village (永平寨) in Guangxi for trading between China and Vietnam, in which rich Vietnamese merchants exchanged gold, silver, copper coins, *Chen Xiang* (沉香 Aquilariae Lignum Resinatum), elephant teeth and rhino horns for Chinese medicinal materials, silk and paper.[12]

In addition to the Sino-Vietnamese border "trade", Vietnam also often sent people to China to buy a large number of medicinal materials, as it was quoted in volume 5 of *Leng Lu Yi Hua* (《冷庐医话》*Medical Discourses of the Cold Shack*) by Lu Yitian (陆以湉) in the Qing dynasty from *Qian Tang Xian Zhi* (《钱塘县志》*Qiantang County Records*) that in Southern Song dynasty, Vietnamese merchants came to Lin'an (临安) to purchase a large amount of *Tu Fu Ling* (土茯苓 Smilacis Glabrae Rhizoma), resulting in an increased price of the medicine.[13] At the time of Song and Yuan dynasties, despite of war for years, the medical exchanges were not cut off between China and Vietnam. "The Song dynasty has satin, medicinal materials and other things and sells them in the market (宋有缎子、药材等物，置卖为市)". From the thirteenth year of Zhiyuan (至元) in the Yuan dynasty (1276), the Shengzong (圣宗) of Vietnam, Chen Huang (陈晃), "sends Tao Shiguang (陶世光) to Longzhou (龙州) on a mission to buy medicine and investigate the situation of Yuan people".[14] It can be seen that the trade of medicinal materials was extremely frequent between China and Vietnam at that time.

During the exchanges between China and Vietnam, Chinese medicines continued to be introduced into Vietnam, and at the same time, Vietnamese exotic medicines were also introduced into China in the form of tributary and non-governmental trade.[15] In the early Eastern Han dynasty, Ma Yuan (马援) went on an expedition to Jiaozhi and brought back a large amount of *Yi Yi Ren* (薏苡仁 Coicis Semen). According to *Hou Han Shu Ma Yuan Zhuan* (《后汉书·马援传》*History of the Latter Han Dynasty: Biography of Ma Yuan*): "Initially, when Yuan was in Jiaozhi, he often consumed coix seed, which helped to lighten the body and reduce desires, thereby countering the harmful miasma. The coix seeds in the southern region were large, and Yuan intended to use them as seeds. When the army returned, he carried a cartload of them (初，援在交阯，常饵薏苡实，用能轻身省欲，以胜瘴气。南方薏苡实大，援欲以为种，军还，载之一车)". At the beginning of the Three Kingdoms Period, Zhang Jin (张津) served as a magistrate in Jiaozhi and sent Cao Cao (曹操) *Yi Zhi Ren* (益智仁 Alpiniae Oxyphyllae Fructus) produced in Vietnam as a gift.[13]

According to volume 49 of *San Guo Zhi* (《三国志》*Records of the Three Kingdoms*), "whenever Xie (燮) sent an envoy to Sun Quan (孙权), he gave thousands of various spices and exquisite ko-hemp cloth as gifts (燮每遣使诣权，致杂香、细葛，辄以千数)".[16] Since then, Vietnamese medicine has been increasingly introduced into China. *Chen Xiang*, *Yu Jin* (郁金 Curcumae Radix) and *Su He Xiang* (苏合香 Liquidambar orientalis Mill.) produced in Vietnam as recorded in *Liang Shu Fu Nan Zhuan* (《梁书·扶南传》*History of the Liang Dynasty: Biography of Funan*), and *Shui Su* (水苏 Stachys japonica Miq) as well as *Shi Liu Huang* (石硫磺 Sulfur) produced in Vietnam as recorded in *Ming Yi Bie Lu* (《名医别录》*Miscellaneous Records of Famous Physicians*), were all imported into China from Vietnam. By the Tang dynasty, according to Su Jing's (苏敬) *Tang Ben Cao* (《唐本草》*Tang Materia Medica*) and Chen Zangqi's (陈藏器) *Ben Cao Shi Yi* (《本草拾遗》*Supplement to "The Grand Compendium of Materia Medica"*), the medicines shipped from Vietnam at that time included *Bai Hua Teng* (白花藤 Wisteria venusta), *An Mo Le* (庵摩勒 Phyllanthus emblica Linn.), *Ding Xiang* (丁香 Caryophylli Flos), *He Li Le* (诃黎勒 Terminalia Chebula), *Su Fang Mu* (苏方木 Caesalpinia sappan Linn.) and *Bai Mao Xiang* (白茅香 Imperatae Rhizoma), among which a large amount of *Su Fang Mu* was imported.

Vietnam was an important country that paid tribute to the Song dynasty. According to *Song Shi* (《宋史》*History*

of the Song Dynasty), Jiaozhi paid tribute to China dozens of times in the Song dynasty. The main types of tribute brought by Jiaozhi envoys were spices, medicinal materials, pearls, hawksbill turtles and rhino horns, etc. Located in the middle of Vietnam, the ancient country "Zhan Cheng (占城)" also paid tribute to the Song dynasty for more than 40 times, among which the quantity of aromatic medicinal herbs was very large, and amounted to more than 100 thousand jin in each tribute.[17] In the Song dynasty's *Zhu Fan Zhi* (《诸蕃志》 *Records of Foreign Countries*), it is also described that Jiaozhi used local medicines as tributes, "locally-produced *Chen Xiang*, *Peng Lai Xiang* (蓬莱香 Aquilaria sinensis), gold and silver, iron, cinnabar, pearls and shells, rhino horns and ivories, feathers and kingfishers, tridacna, salt, lacquer, kapok and silk cotton are used as tributes every year". It was recorded in Volume 488 of *Song Shi* that medicines were brought from Zhancheng to China as tributes, "In the second year of Tianxi (天禧二年), the king sent an envoy to pay tributes, including 72 ivories, 86 rhino horns, 1,000 shells of *Dai Mao* (玳瑁 Eretmochelys imbricata), 50 *jin* (斤) of *Ru Xiang* (乳香 Olibanum), 80 *jin* of *Ding Xiang*, 65 *jin* of *Dou Kou* (豆蔻 Amomi Fructus Rotundus), 100 *jin* of *Chen Xiang*, 200 *jin* of *Jian Xiang* (笺香 Aquilaria sinensis), 68 *jin* of *Bie Jian* (别笺), 100 *jin* of *Hui Xiang* (茴香 Foeniculum vulgare Mill.) and 1500 *jin* of *Bing Lang* (槟榔 Arecae Semen)". In Yuan dynasty, Vietnam continued to be in a vassal relation with China, and in the third year of Yuan Shizu Zhongtong (元世祖中统三年), it was stipulated that "beginning from the fourth year of Zhongtong, a tribute should be paid every three years with *Ne Ciding* (讷剌丁 official of the Yuan dynasty) as the official who carried a *Hu Fu* (虎符 tiger-shaped tally of military authority) and travelled to and from the country of Annan (自中统四年始，每三年一贡，仍以讷剌丁充达鲁花赤，佩虎符，往来安南国中)".[18] Vietnam paid a total of 52 tributes to the Yuan dynasty, of which *Su He You* (苏合油 Sect. Liquidambar), *Zhu Sha* (朱砂 Cinnabaris), *Chen Xiang*, *Tan Xiang* (檀香 Santali Albi Lignum), *Xi Jiao* (犀角 Rhinoceros nicornis LR.simus Burchell) and other medicines played an important role in the tribute.[12] Vietnam was also the country which paid tribute to the Ming dynasty the earliest. According to relevant materials, from the first year of Hongwu (洪武元年, 1368) to the tenth year of Chongzhen (崇祯十年, 1637), Annan paid tribute 79 times, and Zhancheng 72 times. Among the tributes were *Dou Kou*, *Tan Xiang*, Xi Jiao, *Hu Jiao* (胡椒 Piperis Fructus) and other medicines.[19] When the Vietnamese government paid tribute to the Ming government, it often proposed to exchange the tribute for Chinese books, medicinal materials and other things they lacked. For example, in the first year of Tianshun (天顺元年, 1457) in the Ming dynasty, Li Wenlao (黎文老), a vassal of the Vietnamese king reported that "Poetry and books are good for the heart, and medicine and stone needles prolong the life. Since ancient times, Chinese books and medicinal materials in this country are used to clarify morality and justice, and lengthen the span of life. Today, I would like to follow the old customs to take to China our local spices and other things that the country does not have, and bring in return Chinese books and medicines (诗书所以淑人心，药石所以寿人命，本国自古以来每资中国书籍、药材，以明道义，以跻寿域。今乞循旧习，以带来土产香味等物易其所无，回国资用)". Emperor Yingzong of the Ming dynasty (明英宗) immediately granted the request of Vietnam.[20] It can be seen that this tribute trade played an important role in the exchange and development of medicine between China and Vietnam when there was a strict ban on maritime trade in the Ming dynasty. The import and export of foreign medicines did not stop despite wars, maritime bans and other reasons.

It can be seen that Chinese medicines were continuously introduced into Vietnam through folk exchange, border trade, tribute and other ways, which enabled Vietnamese people and doctors to use Chinese medicines, and promoted the clinical application of Chinese medicines in Vietnam. At the same time, the introduction of Vietnamese aromatic medicinal herbs to China greatly increased the varieties of Chinese herbal medicine, and the introduction of Vietnamese aromatic medicinal herbs also urged Chinese scholars to re-examine the theory of *Si Qi Wu Wei* (四气五味 four qi and five flavours) in *Huang Di Nei Jing* (《黄帝内经》 *The Yellow Emperor's Inner Classic*), bringing forth new ideas and promoting the development of Chinese medicine theory. Based on the exchange of medicine, the herbology has been integrated and exchanged between China and Vietnam.[21]

4 Exchanges of medical practitioners

According to historical records, in 257 BC, the Chinese doctor Cui Wei (崔伟) practiced medicine in Vietnam for many years, cured Yong Xuan (雍玄) and Ren Xiu (任修) of their illness of weakness, and wrote the book *Gong Yu Ji ji* (《公余集记》 *Collections Recorded in Spare Time after Work*), which was circulated in Vietnam and was the beginning of the introduction of Chinese medicine to Vietnam. Dong Feng (董奉), a famous doctor in the Three Kingdoms Period, went to Vietnam to treat the then Vietnamese official Shi Xie (士燮); Lin Sheng (林胜), the "Cangwu Taoist (苍梧道士)" in Southern Qi, went to Vietnam to collect herb medicines and cured Yin Keng's wife of abdominal distension with "*Wen Bai Wan* (温白丸 Warming White Pill)", which was then introduced into Vietnam.[22] In the Sui and Tang dynasties, Shen Guangxun (申光逊) used *Hu Jiao*, *Gan Jiang* (干姜 Zingiberis Rhizoma) and other spicy medicines to cure Sun Zhong'ao (孙仲敖), a native of Annan of brain pain. In the sixth year of Shaoxing in the Song dynasty (宋绍兴六年, 1136), Chinese monk Ming Kong (明空) used spiritual therapy to cure the Vietnamese Emperor

Shenzong (神宗皇帝) of the Li dynasty of his serious illness, and he was highly revered and got the title "imperial teacher". Around the 14th century, Chinese acupuncture and moxibustion spread widely in Vietnam, and Zou Geng (邹庚), an acupuncturist in the Yuan dynasty, went to Vietnam to practice medicine with good efficacy, earning him the reputation of the "miracle-working doctor". The emperor Chen Hao (陈晖) of the Chen dynasty in Vietnam once experienced drowning in his childhood. Dr. Zou Geng saved him by using acupuncture, indicating that acupuncture had already been introduced to Vietnam at that time. Superb medical skills of Chinese doctors have been widely praised by Vietnamese people. The rulers of Vietnam also had great respect for famous Chinese doctors. The last feudal dynasty of Vietnam (Ruan dynasty 阮朝) built a temple to worship the outstanding medical practitioners of the past dynasties, many of whom were famous ancient Chinese doctors, such as Sun Simiao (孙思邈), Bian Que (扁鹊), Ge Hong (葛洪), Yu Fu (俞跗), Zhang Ji (张机) and so on. The sacrificial ranking was exactly the same as the Sanhuang Temple (三皇庙) built in the Yuan and Ming dynasties.[23] In history, a steady stream of Chinese doctors came to Vietnam to practise medicine, which speeded the spread and promotion of TCM in Vietnam. On this basis, combined with the local humid subtropical climate and geographical location, as well as the fact that the local residents were prone to suffer from heat, rheumatic and gastrointestinal diseases, Vietnamese medicine drew on the local people's experience in medicine and gradually developed through the long-term unremitting efforts of Chinese and Vietnamese doctors.[24]

Under the influence of Chinese medicine and doctors, some famous doctors also appeared in Vietnam. They were called to China to cure diseases for the emperor and the people of China. For example, after Emperor Shizu of Yuan dynasty (元世祖) established a suzerain-vassal relationship with the Chen dynasty of Vietnam, he required Vietnam to send three physicians as tribute every three years. According to *Yuan Shi* (《元史》 *History of the Yuan Dynasty*): "Since you have pledged loyalty as a subject, starting from the fourth year of Zhongtong, you were to send tribute every three years. You may select Confucian scholars, physicians, and those skilled in the arts of divination, as well as other craftsmen, with three of each (卿既委质为臣，其自中统四年为始，每三年一贡，可选儒士、医人及通阴阳卜筮、诸色人匠，各三人)". Emperor Chengzu of Ming dynasty (明成祖) recruited craftsmen from Jiaozhi to serve in China. The famous Vietnamese doctor Ruan Bojing (阮伯靖) (Fig. 1) was recruited to China in the Ming dynasty in 1384, and cured the postpartum illness of a princess consort.[25] The Ming Emperor appreciated his talent, granted him the title of *Chan Shi Da Yi* (禅师大医 Great Doctor of Zen Master) and kept him in the Imperial Institute of Medicine to practice medicine.[26] In June of the fifth year of Yongle

Figure 1 An image of Huijing Zen Master (source with permission from: https://tueyduong.com/dai-y-thien-su-tue-tinh/)

(永乐五年, 1407), Emperor Chengzu said to Zhang Fu (张辅), general commander of Jiaozhi, Hou Muchen (侯沐晨), left vice general, and Liu Xie (刘携), the military secretary, that "Jiaozhi should have people that are virtuous, knowledgeable and fond of living alone in the mountains and forests ... Those who know yin-yang (阴阳), fortune-telling and medicine should be found carefully and sent to the capital for promotion (交趾应有怀才抱德、山林隐逸、明经能文、博学有才.....阴阳术数，医药方脉之人、悉心访求，以礼遣送赴京擢用)".[27] In September of the fifth year of Yongle (1407), Zhang Fu sent "770 craftsmen (including doctors) from Jiaozhi to Nanjing (南京), the capital of Ming dynasty". In October, another 900 craftsmen were sent to the capital. In the 11th year of Yongle (1413), more than 130 Jiaozhi artisans brought their families to Nanjing and cured many difficult diseases.[28] At the end of the Ming dynasty and the beginning of the Qing dynasty, a group of special doctors known as "Overseas Chinese Doctors" emerged in Vietnam.[29] During the late Ming period, China was embroiled in political turmoil. Li Zicheng (李自成) led a rebellion against the Ming dynasty, and the Manchu people of the Qing dynasty took control of the entral plains. Many people, unable to endure the chaos of war, fled southward to Vietnam to escape the conflict, among whom were numerous doctors. *Mo Shi Jia Pu* (《莫氏家谱》 *The Mo Family Genealogy*) records: "During the great turmoil at the end of the Ming dynasty, our ancestor, Mo Jiu (莫玖), fled south to Vietnam to escape the invasion of the minorities (明末大乱，我莫太公玖，因不堪胡虏侵扰之乱，越海南投)".[30] At that time, there were about a thousand people who traveled with him, most of whom were his relatives or fellow villagers.

Some of these overseas Chinese doctors, who had practiced medicine in Vietnam for a long time, earned the respect and admiration of the local people. In fact, out of

deep reverence for them, some even established temples in their honor and deified them. Some overseas Chinese doctors also participated in military activities while practicing medicine in Vietnam. For example, *Da Nan Shi Lu* (《大南实录》 *Great Annals of the South*) records: "In the fifteenth year of the Mingming reign (明命十五年), in Jiading (嘉定), a medical practitioner named He Wenli (何文力) used his own medicine to treat diseases, and many soldiers recovered (明命十五年，嘉定有业医者何文力，自出家药以治病，兵痊愈者众)". Although this historical record does not explicitly state that He Wenli was an overseas Chinese, other historical sources note that "Those in professions such as witchcraft, medicine, fortune-telling, and arithmetic were all of Chinese origin (其巫祝医命、星卜算术诸家，皆唐人为之)",[31] suggesting he was a Chinese. When the Vietnamese emperor heard about this, he "bestowed upon him the rank of a ninth-grade doctor and ordered to pay him according to what was needed (赏授正九品医生，令照所需还其值)". Another example is the Qing official Yang Duanpeng (杨端朋), who also joined the military to practice medicine and treated more than 4,000 soldiers. The Vietnamese government first rewarded him with clothing and silver, and later, after an official reported that Yang had treated a large number of soldiers, they "further rewarded him with 100 taels of silver and appointed him as a doctor in the Imperial Institute of Medicine, with a seventh-grade rank, under the jurisdiction of Jiading province (复加赏白金一百两，授太医院医正，秩从七品，隶嘉定省)".

With the large migration of Chinese to Vietnam, many overseas Chinese physicians opened herbal medicine stores or general stores selling Chinese medicinal herbs. *Jia Ding Tong Zhi* (《嘉定通志》 *Comprehensive Annals of Jiading*) once described the prosperity of Chai Gun (柴棍), the largest commercial center in southern Vietnam at the end of the 18th and early 19th centuries: "Goods sold include brocade, porcelain... bookshops, herbal medicine shops, tea houses, noodle shops, and there is nothing that cannot be found in the rivers and ports of the north and south".[32] In the 31st year of the Guangxu reign (光绪三十一年, 1905), Yan Qu (严璩) traveled to various places in Vietnam for more than two months and wrote *Yue Nan You Li Ji* (《越南游历记》 *Travel Notes on Vietnam*), in which he stated, "The Vietnamese still use traditional Chinese methods in medicine (越南人医药仍用中国旧法)". Chinese medicinal materials were imported into Vietnam, with *Chuan Xiong* (川芎 Rhizoma Chuanxiong), *Bai Zhu* (白术 Rhizoma Atractylodis Macrocephalae), *Dang Gui* (当归 Angelicae Sinensis Radix), *Fu Ling* (茯苓 Poria), *Sheng Di* (生地 Rehmanniae Radix), *Gan Cao* (甘草 Glycyrrhizae Radix et Rhizoma), and *Bai Shao* (白芍 Paeoniae Radix Alba) being the most common. Before the French occupation, around 100,000 *dan* (担 a traditional Chinese unit of weight) of medicinal materials were imported annually, and even in the early 20th century, this figure still reached 20,000 *dan* per year. Overseas Chinese doctors also opened herbal medicine stores in various parts of Vietnam. For example, in Haifang (海防), there was "*Yong Cui Tai* (永萃泰)" owned by a Guangdong native named Cheng Kongzhi (程孔之); in Henei (河内), there were "*An He Tang* (安和堂)" by Guo Chengji (郭成记), "*Xiang Chun Tang* (祥春堂)" by Zhu Sanji (朱三记), "*Pu Sheng Tang* (普生堂)" by Huang Wan (黄万), "*Guang Sheng Tang* (广生堂)" by Guan Jieqing (关杰卿), "*De Sheng Tang* (德生堂)" by Guan Yiji (关意记), and "*Yong He Cheng* (永合成)" by Guo Zaoyuan (郭藻元); in Anpei (安沛), there were "*Yao He Tang* (夭和堂)" by Pan Jia (潘佳) and "*Zi Shou Tang* (滋寿堂)" by Liang Xuecai (梁学才). These herbal medicine merchants organized industry associations called "Pharmaceutical Guilds. Overseas Chinese in Vietnam also established hospitals. In 1901, in the area known as "Chinatown", they founded a maternity hospital and set up schools to train midwives.

Medical expert exchanges between China and Vietnam became a link of medical exchanges between the two countries. Chinese doctors brought the healing ideas and methods of TCM to Vietnam, which promoted the development of Vietnamese medicine. On this basis, Vietnamese doctors developed their own traditional medicine considering the characteristics of local climate and the physique of local residents, and brought it to China through physician recruitment by the Chinese government, promoting the mutual integration of medicine between the two countries.

5 The dissemination and evolution of Chinese medical books

As a special commodity carrying scientific knowledge and cultural spirit, books have political and cultural value beyond that of general commodities. The transmission of Chinese books to Vietnam has a great and far-reaching influence on Vietnamese culture.[33] As an important part of the "Sinophone cultural sphere", the relationship between China and Vietnam is closer than that of any other country in Southeast Asia. As a part of China's territory for a long time, Vietnam has been deeply influenced by China in politics, economy and culture. The Chinese language has been promoted in Vietnam, and Chinese classics have also been imported into Vietnam.[34] *Huang Di Nei Jing*, *Ben Cao Gang Mu* (《本草纲目》 *The Great Compendium of Materia Medica*), *Dong Yuan Shi Shu* [《东垣十书》 *Ten Books by* (*Li*) *Dongyuan*], *Jing Yue Quan Shu* [《景岳全书》 *The Complete Works of* (*Zhang*) *Jingyue*], *Yi Xue Ru Men* (《医学入门》 *Introduction to Medicine*), *Shou Shi Bao Yuan* (《寿世保元》 *Prolonging Life and Preserving the Origin*) and other medical classics also entered Vietnam by means of book exchange between China and Vietnam. Chinese medical books were highly valued in Vietnam. Vietnamese doctors studied these books and developed Chinese medicine considering the characteristics of local

climate and medicinal herbs, and wrote many medical books in Chinese or Han-Nôm (汉喃) language.[35] For example, the book of *Ba Zhen Quan Shu* (《八阵全书》*Complete Manual of Eight Military Formations*) (the author is unknown) in Vietnam was based on *Jing Yue Quan Shu*. In the sixth year of Xuande in the Ming dynasty (明宣德六年, 1432), Vietnamese Pan Fuxian (潘孚先) wrote a book titled *Ben Cao Zhi Wu Zhuan Yao* (《本草植物纂要》*Compendium of Materia Medica Plants*), which collected a large number of Chinese medicines. In addition, the famous Vietnamese medical books such as *Zhong Yue Yao Xing He Bian* (《中越药性合编》*Compilation of Sino-Vietnamese Medicinal Properties*), and *Nan Yao Shen Xiao* (《南药神效》*Miraculous Medicine of the Southern Country*) (Fig. 2) were all written under the influence of TCM.[36] *Hai Shang Yi Zong Xin Ling Quan Zhi* (《海上医宗心领全帙》*Complete Compendium of Essential Medical Knowledge from Hai Shang Lan Weng*) (Fig. 3) written by Vietnam's "medical sage" Li Youzhuo[37] (黎有卓) was the first complete medical book in the country. It learned from *Huang Di Nei Jing* in theory, and included many medicines, half of which were Chinese medicines, and the other half Vietnamese medicines. The medical prescriptions included in the book such as *Gui Zhi Tang* (桂枝汤 Cinnamon Twig Decoction) and *Ren Shen Bai Du San* (人参败毒散 Ginseng Toxin-resolving Powder) were from Chinese medicine.[38] Other books, like *Xian Chuan Dou Zhen Yi Shu* (《仙传痘诊医书》*Immortal-transmitted Medical Classic on Smallpox Diagnosis and Treatment*) by Fan Baifu (范百福) and *Yi Shu Chao Lue* (《医书抄略》 *Medical Book Copy*) by Wu Shoufu (武手府) (an acupuncture book), were also written under the influence of TCM.

Tribute trade is an official commodity trade with tributary relationship. Books were often included in the goods returned by China to Vietnam. In the official

Figure 2 *Nan Yao Shen Xiao* (《南药神效》*Miraculous Medicine of the Southern Country*) (source with permission from: National Library of Vietnam)

Figure 3 Pages of *Hai Shang Yi Zong Xin Ling Quan Zhi* (《海上医宗心领全帙》 *Complete Compendium of Essential Medical Knowledge from Hai Shang Lan Weng*) (source with permission from: National Library of Vietnam)

exchanges between China and Vietnam in the Tang and Song dynasties, books were important items for Vietnamese officials' attention. According to statistics, from the middle of the 17th century to the 19th century, Vietnam sent about 80 missions to China. At that time, Vietnamese envoys and officials often made friends with Chinese officials to get books as gifts, and they also bought books from different places in China, playing a very important role in the process of spreading Chinese books to Vietnam.[39] There was a great demand for Chinese books in Vietnam, and various communication channels between China and Vietnam were smooth, so many Chinese classics were imported into Vietnam. According to a survey conducted by scholars on the collections of Vietnamese Han-Nôm Research Institute, the Literature Institute, the History Institute and the National Library of Vietnam at the Vietnam National Center for Social Sciences, Han-Nôm documents collected by the French Far Eastern Institute, the Oriental Writing Department of the French National Library, and the French Asiatic Society Library in *Yue Nan Han Nan Wen Xian Mu Lu Ti Yao* (《越南汉喃文献目录提要》 *Catalogue of Han-Nôm Documents in Vietnam*)[40] published in 2004 by the Humanities and Social Sciences Center of Academia Sinica in Taiwan, China as well as the Japanese *Dong Yang Wen Ku An Nan Ben Mu Lu* (《东洋文库安南本目录》*Catalogue of Annam Books in the Toyo Bunko*) and *Gu Shu Yuan Shu Ji Shou Ce* (《古书院书籍手册》*Ancient Academy Books*). There were a total of 514 kinds of Annan Chinese classics, including 39 kinds of Confucian classics, 18 kinds of historical records, 406 kinds of philosophical writings, 51 kinds of miscellaneous works,[41] reflecting the dissemination of Chinese books in Vietnam.[42] In the process of book exchange between China and Vietnam,

envoys, monks and taoists, officials and soldiers, expatriates and businessmen were all important media. In addition, Chinese bookshops also played an important role in the exchange. For example, there were many bookshops in Guangzhou (广州) and Foshan (佛山), and the books they printed were "sold in central, northwestern and southern China, as well as the South Ocean Islands (including Vietnam). Many workers were needed for printing and folding of books, with the number of workers no less than a thousand [行销内地、西北、江南、南洋群岛 (含越南)，印刷摺叠，需人颇多，盛时不下千人云]", and it can be seen that Guangzhou and Foshan were among the important supplying places of Chinese books to Vietnam, with famous bookshops of *Jin Yu Tang* (金玉堂), *Jin Wen Tang* (近文堂), *Ying Wen Tang* (英文堂), *Wen Yuan Tang* (文元堂), *Tian Bao Lou* (天宝楼), *Bao Hua Ge* (宝华阁), *Zi Lin Shu Ju* (字林书局), *Rong He Yuan* (荣和园), *Sheng Nan Zhan* (盛南栈), *Shi Jie Yuan* (拾介园), *Wu Yun Lou* (五云楼), etc. In particular, the owners of Foshan book shops like *Shi Jie Yuan* and *Wu Yun Lou* are keen on engraving Chinese books for Vietnamese people, which has become a spectacular landscape of book engraving in southern China, showing the openness of Guangdong in book export at that time.[34]

Chinese medical books arrived at Vietnam, and spread and developed locally, so that a medical culture that is harmonious yet different from China came into existence in the country. Mayanagi Makoto, a Japanese scholar, compared medicine in the Sinophone cultural sphere to the fruits of various trees cultivated in the medical forest of China (abundant medical books in the past dynasties of China), which was spread to neighboring countries. Then the countries selected seeds adapted to their local culture, and cultivated the seeds or hybridized them with local ones, absorbing foreign knowledge genes, and produced new fruits (ancient medical books of Vietnam).[43]

6 Conclusion

Since the Qin dynasty, when Chinese characters were first introduced to Vietnam, until the French colonial period abolished their use in 1918, Vietnam used Chinese characters for over two thousand years. During this time, a large number of medical books written in classical Chinese were created. For nearly a thousand years, from Emperor Wu of Han's pacification of Nan Yue until Vietnam became a French colony, the two countries maintained a "suzerain-vassal relationship," which fostered close political, economic, and cultural ties. Chinese medicinal materials were continuously introduced to Vietnam through folk medicine exchanges, border trade fairs, and tributary bestowals. At the same time, Vietnamese aromatic medicinal herbs were introduced to China, promoting reciprocal integration in the study of materia medica. The mutual visits of medical practitioners between the two nations served as a crucial bridge for Sino-Vietnamese medical exchanges. Chinese medical books circulated in Vietnam, where they were disseminated and adapted locally, allowing the country to develop its own traditional medical system. This system, while theoretically and technically aligned with Chinese medicine, also developed distinct characteristics.

Future research into Vietnamese medical books could explore, through new materials, how different aspects of Chinese traditional medicine—such as various doctrines and specialized disciplines—were transmitted, absorbed, and applied in Vietnam. Additionally, it can examine how the Vietnamese constructed their own traditional medicine by incorporating Chinese medical knowledge. Further analysis will reveal the unique aspects of traditional Vietnamese medicine and offer insights into the process of "acceptance—adaptation—innovation" of traditional medicine in Vietnam.

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Ethical approval

This study does not contain any studies with human or animal subjects performed by any of the authors.

Author contributions

LIU Yixuan wrote this article. YANG Lina revised the manuscript, and RUAN Mingyu provided relevant materials.

Conflicts of interest

The authors declare no financial or other conflicts of interest.

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Original Article

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Experimental Research Progress and Transformation Strategy Analysis of Dunhuang Medical Prescriptions

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Abstract

Dunhuang medicine is an important part of Dunhuang studies, boasting rich and comprehensive connotations. It records more than 1,000 Dunhuang medical prescriptions, involving internal, external, gynecological, pediatric, Buddhist, and Daoist medicine, and has demonstrated good clinical effects. However, the mechanism of action of relevant Dunhuang medical prescriptions is still unclear, existing research lacks systematic review and summarization, which has limited their further development. At the same time, the inheritance, innovation, and transformation of Dunhuang medicine are critical issues for the development of Dunhuang medicine, which has important guiding significance for the future development of Dunhuang medicine. Therefore, this study systematically summarizes the experimental research progress of Dunhuang medical prescriptions [except for those contained in *Fu Xing Jue Zang Fu Yong Yao Fa Yao* (《辅行诀脏腑用药法要》*The Guideline to Use Medicines for Zang-fu)*], and seven such prescriptions were selected based on three criteria: well-preserved texts, no prior transmission to the outside world, and having extensive research and clinical application over the past decade. The findings indicate that this type of prescription is applicable to a broad spectrum of diseases and has a promising application prospect in health preservation and disease prevention, as it exerts therapeutic effects through multiple targets and pathways. Based on this, specific strategies for the transformation of Dunhuang characteristic prescriptions were proposed from three aspects: inheritance, innovative development, and transformation strategies, aiming to provide insights for the future development of Dunhuang medical prescriptions.

Keywords: Dunhuang medicine; Dunhuang medical prescriptions; Development and transformation of Dunhuang medicine; Traditional Chinese medicine

1 Introduction

Since the opening of the Silk Road, Dunhuang (敦煌) has become the center of cultural exchanges and convergence between the East and the West because of its special geographical location of "National intersection (华戎所交一都会)" which is of great historical and cultural value. In 1900, about 50,000 volumes of Dunhuang documents (i.e. Dunhuang manuscripts) were found in the Dunhuang Grottoes, which led to the rise of a world-famous study Dunhuang studies.[1] There are a large number of traditional Chinese medicine (TCM) documents in Dunhuang manuscripts. In 1915, Luo Zhenyu (罗振玉) photocopied *Kai Yuan Xie Ben Ben Cao Jing Ji Zhu Xu Lu Can Juan* (《开元写本本草经集注序录残卷》*Fragmented Volume of Preface to the Collection of Notes on the Manuscript of Kaiyuan*) manuscript, making Dunhuang medical literature available for the first time. In 1919, *The Origin of Chinese Materia Medica and Shen Nong's Classic of the Materia Medica* (《中国本草学的起源与神农本草经》) published by Japanese scholar Ogawa Takeji (小川琢治) opened the chapter of Dunhuang medical literature research.[2] With the continuous deepening of sorting and research, Dunhuang medicine came into being and continued to develop.[3] It is also a hot spot of international research. In the book *Medicine in China: A History of Pharmaceutics*, Paul U. Unschuld (文树德), a German sinologist, translated the excerpts from Dunhuang medical literature *Xin Xiu Ben Cao Xu Li* (《新修本草·序例》*Newly Revised Materia*

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Medica: Preface) into English for the first time, opening a precedent for English translation of Dunhuang medical literature.[4] Joseph Needham's *Medical Chinese Medicine: The Dunhuang Medical Manuscripts* combines the research of Dunhuang scholars and TCM scholars from China, the United Kingdom, the United States, France, Japan, Germany and other countries.[5] This research expands international exchanges and cooperation, and can better reflect the characteristics and value of Dunhuang medicine.[6] In addition, international symposiums on Dunhuang culture and translation jointly discuss the translation and dissemination of Dunhuang documents, and the English translation of Dunhuang medical terms has also received widespread attention.[7] In recent years, a series of books, such as the Chinese and English versions of *Dunhuang Medical Research Achievements* (《敦煌医学研究大成》), which was led by Gansu University of Chinese Medicine (甘肃中医药大学), have also been published.

As an important part of Dunhuang studies, Dunhuang medicine is rich in content and comprehensive. It not only absorbed the medical characteristics of Central Plains medicine, Western medicine, ancient Indian medicine, Xizang medicine, etc., but also recorded the contents of medical classics, typhoid fever, diagnostic methods, medical prescriptions, acupuncture and moxibustion, herbal medicine and so on, and elaborated the preparation and application of various medicine dosage forms such as soup, pill, powder, ointment, *Dan* (丹 elixir) and so on. More importantly, it complemented the gap of medical literature before and after the Sui and Tang dynasties, solved some long-term controversial issues in the study of medical history,[8] and contributed more than 1,000 unique prescriptions with Dunhuang characteristics. These prescriptions can be broadly divided into those derived from *Fu Xing Jue Zang Fu Yong Yao Fa Yao* (《辅行诀脏腑用药法要》*The Guideline to Use Medicines for Zang-fu*, *Fu Xing Jue*《辅行诀》for short) and those from other Dunhuang medical volumes. *Fu Xing Jue* and *Shang Han Lun* (《伤寒论》*Treatise on Cold Damage*) are developed from the same ancient lost book *Tang Ye Jing Fa* (《汤液经法》*Materia Medica for Decoctions*), which belongs to the classical prescription system[9] and has different versions in the process of modern circulation. The Dunhuang medical prescriptions discussed in this paper are from other Dunhuang medical volumes besides *Fu Xing Jue*. These prescriptions are well preserved, and the composition of each version is consistent. The Dunhuang Grottoes has not been connected with the outside world for thousands of years, so that it retains the unique characteristics of prescriptions of that period. In addition, Dunhuang medical prescriptions can treat various diseases, including but not limited to internal and external medicine, gynecology and health care. There are also unique Buddhist, Daoist and other medical prescriptions in the history of medicine in the world, and has achieved good results in clinical application.[10–12]

However, how to use modern scientific and technological means to analyze the mechanism and material basis of Dunhuang medical prescriptions is a critical issue for the further promotion and transformation of Dunhuang medical prescriptions. Therefore, this paper reviews the research progress of modern pharmacology of Dunhuang characteristic medical prescriptions in detail, and expounds the practical strategies to realize the transformation of Dunhuang medicine, so as to provide enlightening and constructive ideas for the perpetuate inheritance according to essence, innovative development and modernization of Dunhuang medical prescriptions.

2 Research progress of Dunhuang medical prescriptions

Dunhuang medical prescriptions treat a wide range of diseases, involving internal medicine, external medicine, gynecology, pediatrics and other disciplines, with approximately 1,000 volumes surviving today. The number of prescriptions is about 1,000. What is particularly valuable is that most of these ancient medical prescriptions are verified effective by physicians throughout the Six Dynasties, Sui, and Tang dynasties.[8] Therefore, it is very important to carry out high-quality experimental research on these prescriptions, which has important practical significance for revealing the mechanism and material basis of Dunhuang medical prescriptions. The researchers explored the mechanism of action of these ancient prescriptions through experiments, confirmed their clinical efficacy, and made contributions to the further development of Dunhuang medicine. Therefore, this paper systematically summarizes the experimental research progress of Dunhuang medical prescriptions (except the prescriptions contained in *Fu Xing Jue*), selects 7 Dunhuang medical prescriptions that are well preserved, have not been passed down to the world, have high research popularity in the past 10 years, and are commonly used in clinical practice, and introduces them in order of the number of experimental studies. The classification of prescriptions is based on *Practical Dunhuang Medicine* (《实用敦煌医学》)[13] compiled by Li Yingcun (李应存), which is carried out from the internal medicine and health care related, external use and gynecological prescriptions. As other types of Dunhuang prescriptions are still in the blank field of research, it is expected that there will be more research to supplement the deficiency in the future.

2.1 Medical prescriptions related to internal medicine and health preservation

2.1.1 Dun Huang Si Shi Chang Fu Fang (敦煌四时常服方 Dunhuang Four Seasons Routine Prescription)

Dun Huang Si Shi Chang Fu Fang (敦煌四时常服方 Dunhuang Four Seasons Routine Prescription) (No.

P.2565, lines 39–40) (Fig. 1), also known as *Dun Huang Wei Ci Fang* (敦煌韦慈方 Prescription of Dunhuang Weici), is composed of *Tu Si Zi* (菟丝子 Semen Cuscutae), *Fu Shen* (茯神 Poria cum Radix Pini), *Ren Shen* (人参 Radix et Rhizoma Ginseng), *Yuan Zhi* (远志 Radix Lysimachiae Insignis), *Gui Xin* (桂心 Cortex Cinnamomi). The original text did not record the specific indications and effects, but recorded the administration methods and precautions as follows: "Mash and sift it into powder, and take it two inch dagger with wine. Take it again the next day, gradually increase the dose to three inch dagger. Avoid vinegar and high-temperature cooked pasta, and there are no other notes [右(上)捣筛为散，以酒服之二方寸匕。日再服，服别渐加至三匕。(日)忌大酢热面，余并无妨]". *Dun Huang Si Shi Chang Fu Fang* have been compared with the widely circulated books such as *Bei Ji Qian Jin Yao Fang* (《备急千金要方》*Essential Prescriptions Worth a Thousand Gold Pieces for Emergencies*), *Qian Jin Yi Fang* (《千金翼方》*Supplement to the Essential Prescriptions Worth a Thousand Gold Pieces*), *Wai Tai Mi Yao* (《外台秘要》*Arcane Essentials from the Imperial Library*), etc., and there is no identical medical prescription. Therefore, its medicine composition has a unique style, which is commonly used in modern clinical applications to treat internal medicine diseases such as sinusitis, tinnitus, hair loss, insomnia, dizziness, as well as gynecological menstrual disorders and infertility caused by liver and kidney deficiency and insufficient kidney yang. It is also used to treat male impotence, premature ejaculation, infertility, etc., and achieved good therapeutic effects.[14]

The prescription could prevent and treat cadmium poisoning. Cadmium is a toxic heavy metal widely existing in nature; its incidence has increased due to industrial pollution and human activities, seriously endangering human health. After cadmium enters the human body, it causes liver and kidney dysfunction and inflammatory damage through oxidative stress, lipid peroxidation, inflammatory reaction and other channels. Superoxide dismutase (SOD) can reduce oxidative stress, and malondialdehyde (MDA) can reflect the degree of cell oxidation.[15] Therefore, MDA, SOD, interleukin (IL)-2 and other indicators can be used to respond to cadmium poisoning.[16] *Dun Huang Si Shi Chang Fu Fang* can improve SOD activity and IL-2 level, protect immune injury and oxidative damage in cadmium-exposed rats,[17] repair bone and renal function by reducing the level (or activity) of metabolites such as serum alkaline phosphatase, urea nitrogen and tartrate resistant acid phosphatase 5b levels ($p < 0.05$),[18] antagonize cadmium-induced lipid peroxidation, increase SOD activity to eliminate oxygen free radicals, thereby reducing MDA content, the serum aspartate aminotransferase (AST) activity and kidney index,[19] and thus it exerts cadmium toxicity antagonism and kidney protection. *Dun Huang Si Shi Chang Fu Fang* can also play a role in repairing liver oxidative damage[20] and brain oxidative stress function[21] in rats exposed to cadmium through the above indicators.

The prescription could also improve Alzheimer's cognitive status. One of the causes of Alzheimer's disease (AD) is the abnormal phosphorylation of TUA protein in the brain, and cyclin-dependent kinase and

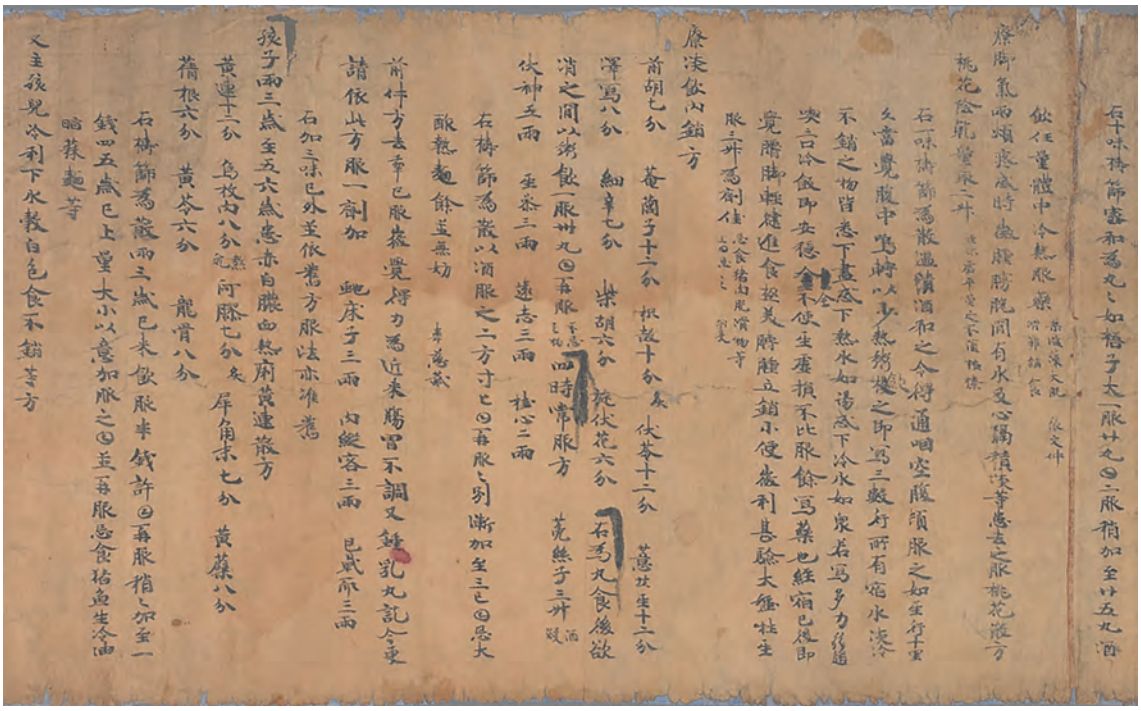

Figure 1 Dunhuang medical literature No. P.2565, *Dun Huang Si Shi Chang Fu Fang,* lines 39–40 (source with permission from: National Library of China, Chinese Ancient Texts Resource Database)

its regulatory protein p35 can inhibit this process.[22] At the same time, extracellular regulated protein kinases (ERK) were also found in neurons of AD patients.[23] Zhai Xiaopu (翟校浦)[24] found through research that *Dun Huang Si Shi Chang Fu Fang* can reduce the expression of p35 and CDK5 proteins and increase the expression of ERK protein, thus playing a therapeutic role in the early stage of AD and mild cognitive impairment (MCI).

2.1.2 Dun Huang Ping Wei Wan (敦煌平胃丸 Dunhuang Stomach-calming Pills)

Dun Huang Ping Wei Wan (敦煌平胃丸 Dunhuang Stomach-calming Pills) (No. P. 3287, lines 124–127) (Fig. 2) is composed of *Shu Da Huang* (蜀大黄 Radix et Rhizoma Rhei), *Dang Gui* (当归 Radix Angelicae Sinensis), *Zhe Chong* (蟅虫 Eupolyphaga seu Steleophaga), *Fang Feng* (防风 Radix Saposhnikoviae), *Shu Fu Zi* (蜀附子 Radix Aconiti Lateralis Praeparata), *Gan Jiang* (干姜 Rhizoma Zingiberis), *Ren Shen*, *Gao Ben* (藁本 Rhizoma Ligustici), *Xuan Shen* (玄参 Radix Scrophulariae), *Ku Shen* (苦参 Radix Sophorae Flavescentis), *Jie Geng* (桔梗 Radix Platycodonis). It is recorded to treat epigastric pain and a sense of suspension, hunger but not wanting to eat (主心悬，饥不用食). The administration method is as follows: "After removing the soil from the herbs, sieve them and mix them with white honey. Before meals, take five pills as large as firmiana seeds with hot soup and sake, twice a day (去土一物下筛，白蜜和。未食前，暖羹清酒服，如梧子五丸，日二服)". *Ping Wei Wan* (平胃丸 Stomach-calming Pills) was originally an ancient medical formula in Wang Shuhe's (王叔和) *Mai Jing* (《脉经》 *The Pulse Classic*) during the Jin dynasty. However, the original composition of the prescription is missing from the literature. After verification, it has been found that *Dun Huang Ping Wei Wan* has many similarities with *Ping Wei Wan* of *Mai Jing*, which compensates for the absence of the prescription in Wang Shuhe's *Mai Jing*.[25] *Dun Huang Ping Wei Wan* is now commonly used in clinical practice to treat headaches caused by epigastric pain and spleen and stomach weakness.[26]

The prescription is proved to have an antitumor effect, especially for gastric cancer. Gastric cancer is one of the malignant tumors with high morbidity and mortality worldwide, and inducing tumor cell apoptosis is one of the main means of treatment at present. Studies have found that the caspase family plays an important role in apoptosis and gastric cancer, among which caspase-3 and caspase-9 are the main mediators, and are affected by the anti apoptotic protein B-cell lymphoma 2 (Bcl-2).[27] *Dun Huang Ping Wei Wan* has been shown to inhibit the growth of transplanted tumor of human gastric cancer cell line SCG-7901 in nude mice by upregulating pro-apoptotic proteins caspase-9 and caspase-3 and downregulating anti-apoptotic protein Bcl-2. It also alleviates cisplatin-induced spleen injury.[28] Further studies indicate that *Dun Huang Ping Wei Wan* can reduce the expression of phosphatidylinositol 3-kinase/AKT/mTOR (PI3K/Akt/mTOR) mRNA and protein ($p < 0.05$, $p < 0.01$), and its mechanism may be related to regulating the expression of key molecules of PI3K/Akt/mTOR

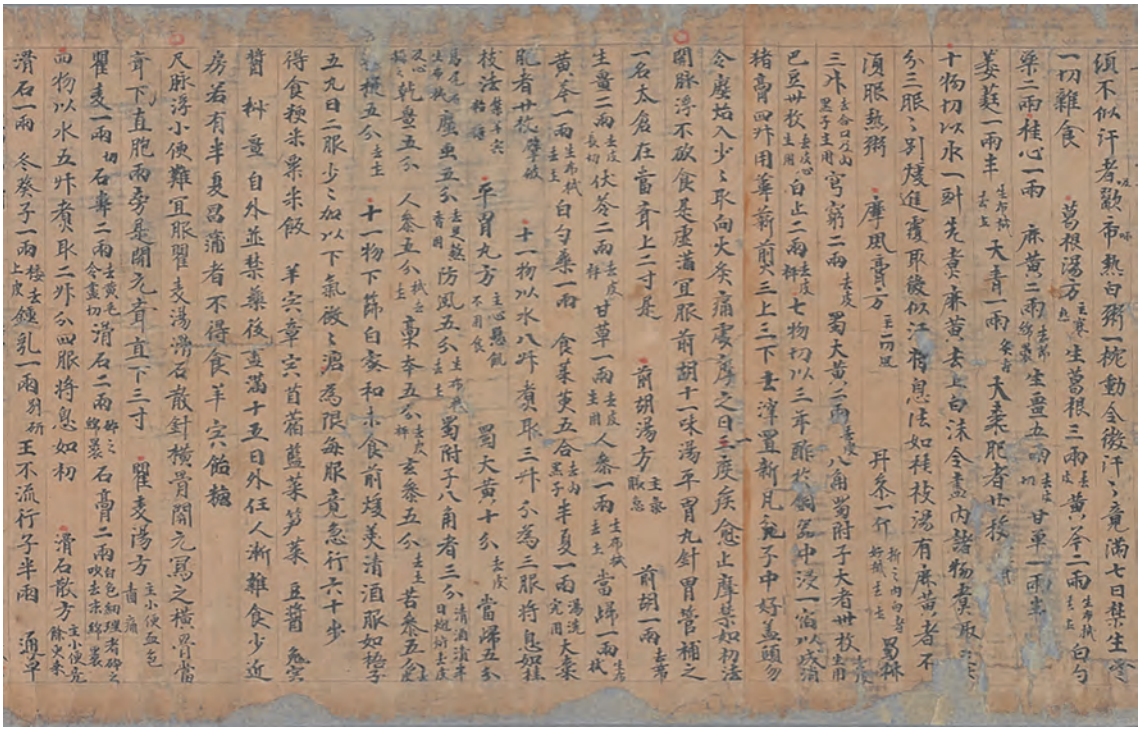

Figure 2 Dunhuang medical literature No. P. 3287, *Dun Huang Ping Wei Wan*, lines 124–127 (source with permission from: National Library of China, Chinese Ancient Texts Resource Database)

signaling pathway.[29] Moreover, when combined with cisplatin, it may enhance the ability of cells to resist oxidative stress by activating the nuclear factor E2 related factor 2/heme oxygenase 1 (Nrf2/HO-1) signaling pathway, thereby reducing cisplatin induced nephrotoxicity.[30] In addition, *Dun Huang Ping Wei Wan* has been found effective in treating gastric precancerous lesions (PLGC). It improves gastric mucosal gland atrophy and intestinal metaplasia in PLGC rats and downregulates the expression of Notch2 and Jagged1—key molecules in the Notch signaling pathway—in gastric mucosal tissues of model rats ($p < 0.05$), thereby contributing to its therapeutic role in PLGC.[31,32]

It could also relieve intestinal mucositis caused by cisplatin. Cisplatin, one of the most effective first-line agents for treating a variety of malignant tumors in clinical settings, induces significant intestinal damage by compromising mucosal integrity and triggering inflammation, thereby increasing the risk of complications such as diarrhea, abdominal pain, vomiting, and even bleeding and sepsis associated with bacterial translocation.[33] Mucosal immune protein (SIgA) is the first line of defense of intestinal mucosal immunity. Occludin and zonula occludens-1 (ZO-1) can control intestinal mucosal permeability.[34] These three can inhibit bacterial translocation, and then inhibit the cascade amplification of inflammatory signals. Studies demonstrate that *Dun Huang Ping Wei Wan* could increase the expression of SIgA in model mice ($p < 0.05$), improve the disruption of jejunal mucosal barrier, and speculated that it increased the relative expression of occludin and ZO-1, and decreased the levels of inflammatory factors IL-6 and tumor necrosis factor-alpha (TNF-α) ($p < 0.05$), so as to improve small intestinal machinery, immune barrier and inflammatory factors, and then alleviate cisplatin induced intestinal mucosal inflammation in mice.[35]

2.1.3 Dun Huang Shen Xian Zhou (敦煌神仙粥 Dunhuang Immortal Porridge)

Dun Huang Shen Xian Zhou (敦煌神仙粥 Dunhuang Immortal Porridge) is a health preserving immortal porridge attached to the Dunhuang medical literature *Hu Xi Jing Gong Miao Jue* (《呼吸静功妙诀》 *Secret of Breath Static Skill*) (No. P.3810, lines 13–15) (Fig. 3), which consists of *Shan Yao* (山药 Rhizoma Dioscoreae), *Qian Shi* (芡实 Semen Euryales), *Jing Mi* (粳米 Oryza Sativa L.), and *Jiu Cai Zi* (韭菜籽 Semen Allii Tuberosi). According to records, it is used to replenish weakness and fatigue, nourish qi and strengthen the mind, strengthen yuan-primordial yang, stop diarrhea, and bring joyful spirit (此粥菩补虚劳，益气强志，壮元阳，止泄，精神妙). Its administration method is as follows: "It's better to take three cups of hot wine after eating the porridge (食粥后用好热酒饮三盃妙)". According to textual research, *Dun Huang Shen Xian Zhou* is the earliest diet therapy in China that uses yam as congee.[36]

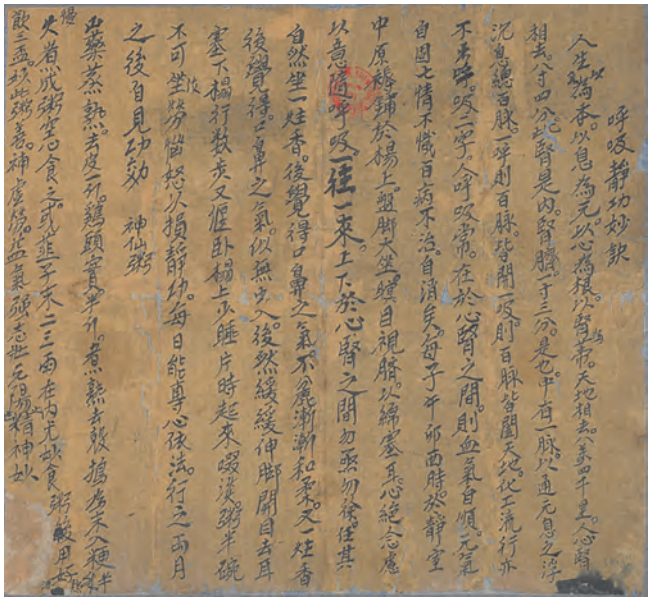

Figure 3 Dunhuang medical literature No. P. 3287, *Dun Huang Shen Xian Zhou*, lines 13–15 (source with permission from: National Library of China, Chinese Ancient Texts Resource Database)

The precription could prevent and treat radiation-induced brain injury. Radiation induced brain injury is a serious complication in the treatment of head and neck cancer, and oxidative stress produced by ionizing radiation will aggravate brain injury. Nrf2 is an endogenous antioxidant defense regulator. Glycogen synthase kinase 3β (GSK-3β) plays a key role in regulating and degrading Nrf2, and phosphorylated GSK-3β can prevent the nuclear translocation of Nrf2 and inhibit the antioxidant response in cells.[37] Liu Xiuzhu (刘秀珠), et al.[38] found that *Dun Huang Shen Xian Zhou* can protect the brain injury of rats caused by X-ray, down-regulate the expression of p-GSK-3β, up-regulate the expression of Nrf2, and reduce the content of inflammatory factors such as TNF-α and IL-1β, so as to regulate oxidative stress and inflammatory response, and alleviate brain tissue radiation injury.

It could also palliate Alzheimer's disease (AD) and have anti-aging effects. AD can significantly cause reduction or even lost of the learning and memory abilities in patients. Apoptosis is the death mode of AD neural cells, studies have shown that protein of Bcl-2 associated x (Bax)/Bcl-2 mediated apoptosis is closely related to the occurrence of AD.[39] Wu Jianjun (吴建军), et al.[40] found through research that *Dun Huang Shen Xian Zhou* can increase the expression of Bcl-2 and Bax genes in hippocampal tissue, thereby inhibiting apoptosis, improving the learning and memory ability of AD, and has a certain anti-aging effect. Aging is an irreversible change in the structure and function of organisms over time. Studies have shown that oxidative stress is closely related to aging,[41] and SOD and MDA can be used to detect oxidative stress injury in AD rats.[42] Ding Gaoheng (丁高恒), et al.[43] found results showing that *Dun Huang Shen*

Xian Zhou could increase thymus index, spleen index and SOD activity, and reduce MDA content.

2.1.4 Dun Huang Gu Ben Fang (敦煌固本方 Dunhuang Body Foundation Strengthening Prescription)

Dun Huang Gu Ben Fang (敦煌固本方 Dunhuang Body Foundation Strengthening Prescription), modified from the Dunhuang ancient medical prescription *Fu Shen Tang* (茯神汤 Fushen Prescription)[44] (No. S.1467V, lines 32–36) (Fig. 4), is composed of *Ren Shen*, *Huang Qi* (黄芪 Radix Astragali), *Bai Zhu* (白术 Rhizoma Atractylodis Macrocephalae), *Min Dang Gui* (岷当归, Radix Angelicae Sinensis), *Chen Pi* (陈皮 Pericarpium Citri Reticulatae), and *Ma Lu Rong* (马鹿茸 Cornu Cervi Pantotrichum). According to records, the prescription primarily treats weakness after exposure to wind, a surging, slippery pulse, neck stiffness, relentlessness, and inability to eat (主治风虚洪滑，颈项强，心气不定，不能食方). The original prescription is similar in composition to *Fu Shen Tang* in *Bei Ji Qian Jin Yao Fang*, and can be referenced to each other.

The prescription could treat irritable bowel syndrome (IBS). Irritable bowel syndrome with diarrhea (IBS-D), the most common subtype of IBS, is characterized by chronic abdominal pain and altered bowel habits.[45] Mast cells play a key role in its pathogenesis by mediating visceral hypersensitivity and intestinal barrier dysfunction through degranulation and release of inflammatory mediators, including tryptase—a marker of mast cell degranulation.[46] Studies have shown that *Dun Huang Gu Ben Fang* alleviates IBS-D symptoms in rat models by modulating several key pathways. It reduces the number of mast cell and tryptase content in colon tissue, along with decreasing 5-hydroxytryptamine (5-HT).[47] Aquaporin 3 (AQP3) and 5-HT are key players in diarrhea pathogenesis, through dysregulated colonic water transport and heightened visceral hypersensitivity, respectively.[48,49] Furthermore, it is found that the prescription upregulates AQP3 and reduce the expression levels of NF-κB, IL-6 and 5-HT. Together, these actions help restore intestinal homeostasis and reduce diarrhea in IBS-D.[50]

The prescription could also relieve exercise-induced fatigue. Exercise-induced fatigue, marked by a temporary decline in physical performance, is associated with impaired myocardial function and can be evaluated by key enzymes: creatine phosphokinase (CK) for ATP resynthesis and L-lactate dehydrogenase (LDH) for glycolytic ATP production, both of which serve as indicators of fatigue and tissue damage.[51,52] Yang Yali (杨雅丽), et al.[53] showed that *Dun Huang Gu Ben Fang* increased CK activity, LDH activity ($p < 0.05$), and other indicators of myocardial tissue in mice, which could improve myocardial energy supply and protect myocardial injury.

2.2 Medical prescription for external use

2.2.1 Dun Huang Rui Cao Gao (敦煌芮草膏 Dunhuang Rue Grass Ointment)

Dun Huang Rui Cao Gao (敦煌芮草膏 Dunhuang Rue Grass Ointment) is a ointment from Dunhuang medical literature (No. P.3731, lines 13–16) (Fig. 5).[54] It consists of *Rui Cao* (芮草 Polygonum multiflorum), *Fu Zi* (附子 Radix Aconiti Lateralis Praeparata), *Dan Shen* (丹参 Radix et Rhizoma Salviae Miltiorrhizae), *Xi Xin* (细辛 Radix et Rhizoma Asari), *Dang Gui*, *Hua Jiao* (花椒 Pericarpium Zanthoxyli), *Wu Zhu Yu* (吴茱萸 Fructus

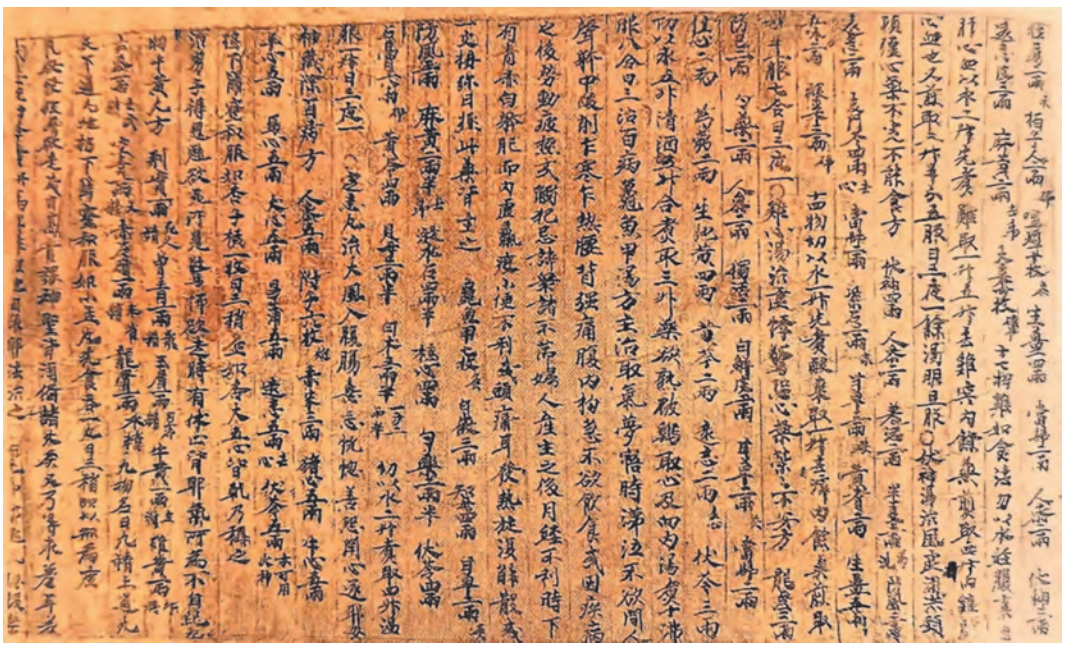

Figure 4 Dunhuang medical literature No.S.1467V, *Fu Shen Tang,* lines 32–36 [source with permission from: *Dunhuang Medical Literature Compilation and Annotations* (《敦煌医学文献辑注》)[9]]

Figure 5 Dunhuang medical literature No.P.3731, *Dun Huang Rui Cao Gao*, lines 13–16 (source with permission from: National Library of China, Chinese Ancient Texts Resource Database)

Evodiae), *Bai Zhi* (白芷 Radix Angelicae Dahuricae), *Zhi Zhu* (踯躅 Rhododendron molle), *Sheng Ma* (升麻 Rhizoma Cimicifugae), *Gui Xin*, *Niu* Su (牛酥 butter), *Bai Zhu*, *Shui Niu Jiao* (水牛角 Cornu Bubali), *Qing Mu Xiang* (青木香 Radix Aristolochiae), *Ding Xiang* (丁香 Flos Caryophylli), *Ling Ling* (零陵 Ocimum basilicum L.), and *Dang Lu* (当陆 Phytolacca acinosa Roxb.). It is recorded that the prescription could treat various foot swelling caused by wind toxins, ulcers, urticaria, severe ulcers, limb stiffness and inability to move independently (主诸风毒脚气，恶肿疼痛，隐疹，恶疮，挛急不随皆主之方). Its administration method is as follows: "Cut the top and soak in vinegar overnight. Fry the beef jerky in oil three times on top and three times on the bottom. Grind off the residue and apply multiple times to the affected area. Rub vigorously to achieve better results (上切溲渍一宿，以醋煎三上三下，绞去滓，病处以受摩涂三数百遍近，大摩之，佳)".

This prescription is effective in treating knee osteoarthritis (KOA). KOA is a degenerative bone and joint disease of the knee, seriously reducing the quality of life of patients. The p38 mitogen activated protein kinase (p38 MAPK) signaling pathway has been confirmed to play a crucial role in the course of knee osteoarthritis, and the proliferation and differentiation of chondrocytes and the synthesis of matrix metalloproteinases (MMPs) are also closely related to this pathway.[55] Li Liangliang (李亮亮), et al.[56] found that *Dun Huang Rui Cao Gao* can regulate p38 MAPK signaling pathway, reduce inflammatory response and cartilage damage, and reduce the levels of matrix metalloproteinase 13 (MMP 13), p38 MAPK, etc., in cartilage tissue, playing a role in protecting cartilage and delaying the progression of KOA.

The prescription could also prevent and treat *Yin Zhen* (隐疹 urticaria). *Yin Zhen*, as a common recurrent skin allergic disease, its itching symptoms severely reduce the quality of life. The pathogenesis of urticaria is primarily driven by IgE-mediated type I hypersensitivity,[57] where elevated cytokines such as IL-4 and TNF-γ contribute to pruritus,[59] and the PI3K/Akt signaling pathway plays a key role in modulating peripheral itch sensation.[58] Shang Yun (尚芸), et al.[60,61] found that *Dun Huang Rui Cao Gao* can exert antipruritic effect through PI3K/Akt signaling pathway, reduce IL-4 and IgE levels, and increase TNF-γ levels ($p < 0.01$), so as to improve the symptoms of pruritus.

It could also treat frostbite. Frostbite refers to the tissue and blood vessel damage that occurs when the body is exposed to the cold environment. Inflammatory response is a key driver of frostbite and soft tissue injury progression.[62] This process is largely mediated by the TLR4/MyD88/NF-κB signaling pathway, which upregulates pro-inflammatory factors such as TNF-α, IL-1β, and IL-6. Conversely, vascular endothelial growth factor (VEGF) can mitigate local inflammation and promote vascular proliferation and wound repair.[63,64] It has been confirmed that *Dun Huang Rui Cao Gao* promotes the healing of frostbite wounds by modulating inflammatory and regenerative pathways. Specifically, it inhibits the TLR4/MyD88/NF-κB axis to reduce the expression of IL-6, IL-1β, and TNF-α, while simultaneously elevating VEGF levels to enhance vascular proliferation and tissue repair, indicative of a multi-target therapeutic mechanism.[65,66]

2.3 Gynecology related medical prescriptions

2.3.1 Dun Huang Chan Hou Feng Xu Shou Ruo Fang (敦煌产后风虚瘦弱方 Dunhuang Postpartum Wind-induced Weakness Emaciation Prescription)

Dun Huang Chan Hou Feng Xu Shou Ruo Fang (敦煌产后风虚瘦弱方 Dunhuang Postpartum Wind-induced Weakness Emaciation Prescription) comes from Dunhuang medical volume (No.P.3930, lines 7–10) (Fig. 6), which

consists of *Dang Gui*, *Sheng Jiang* (生姜 Rhizoma Zingiberis Recens), *Huang Qi*, *Shao Yao* (芍药 Radix Paeoniae), *Chuan Xiong* (川芎 Rhizoma Chuanxiong), *Gui Xin*, *Gan Cao* (甘草 Radix et Rhizoma Glycyrrhizae), *Qiang Huo* (羌活 Rhizoma et Radix Notopterygii), *Gan Zao* (干枣 Fructus Jujubae), and *Yang Jing Rou* (羊精肉 Ovis aries Linnaeus). According to the record, it could treat postpartum weakness due to wind, inability to stand, lack of strength, and shortness of breath (治产后风虚瘦弱，不能立、无力、短气方). Its administration method is as follows: "Boil the lamb in two liters of water first, then remove the lamb. Add medicinal herbs, concentrate the medicine, remove the residue, and take it in three times (以上并切，以水二升，先煮肉，取汁一斗，去肉下诸药。复煎取汁二升半，即去滓，分作三服)". This prescriptions is derived from prescriptions such as *Huang Qi Gui Zhi Wu Wu Tang* (黄芪桂枝五物汤 Astragalus and Cinnamon Twig Five Substances Decoction), *Dang Gui Sheng Jiang Yang Rou Tang* (当归生姜羊肉汤 Chinese Angelica, Fresh Ginger, and Goat Meat Decoction), *Huang Qi Jian Zhong Tang* (黄芪建中汤 Astragalus Center-Fortifying Decoction), etc.[8] It can be seen that these prescriptions focuses on tonifying deficiency and can be used to treat various diseases caused by qi and blood deficiency. Therefore, during its transmission, these prescriptions was simplified as *Dun Huang Chan Hou Feng Xu Shou Ruo Fang*, further expanding its treatment scope.[67]

It has been experimentally proved that *Dun Huang Chan Hou Feng Xu Shou Ruo Fang* could treat polycystic ovary syndrome (PCOS)-ovarian fibrosis. PCOS, a common endocrine disorder, is characterized by ovarian fibrosis.[68] This fibrotic progression is driven by a dual mechanism: impaired angiogenesis due to low expression of VEGF and HIF-1α,[69] and the activation of key pro-fibrotic factors, primarily TGF-β1 and its downstream effector α-SMA.[70] Zhang Xiaohua (张小花), et al.[71] found that *Dun Huang Chan Hou Feng Xu Shou Ruo Fang* can reduce the expression of HIF-1α, VEGF, TGF-β1, α-SMA in rat ovarian tissue ($p < 0.01$, $p < 0.05$), and its therapeutic mechanism may be related to the regulation of HIF-1α/VEGF signaling pathway. At the same time, the team also explored the mechanism of *Dun Huang Chan Hou Feng Xu Shou Ruo Fang* in the treatment of polycystic ovary syndrome through network pharmacology and molecular docking.[72]

The prescription could also treat endometriosis (EMT) dysmenorrhea. EMT is a common gynecological disorder characterized by pelvic pain, dysmenorrhea, and menstrual irregularities.[73] Phosphatidylinositol 3-kinase/protein kinase B (PI3K/AKt) signaling pathway plays a central role in its pathogenesis by promoting the migration and invasion of endometrial cells.[74] Furthermore, it drives disease progression through the upregulation of key downstream effectors, including cyclooxygenase-2 (COX-2) and VEGF, both of which are aberrantly expressed in EMT.[75] Liang Li (梁莉), et

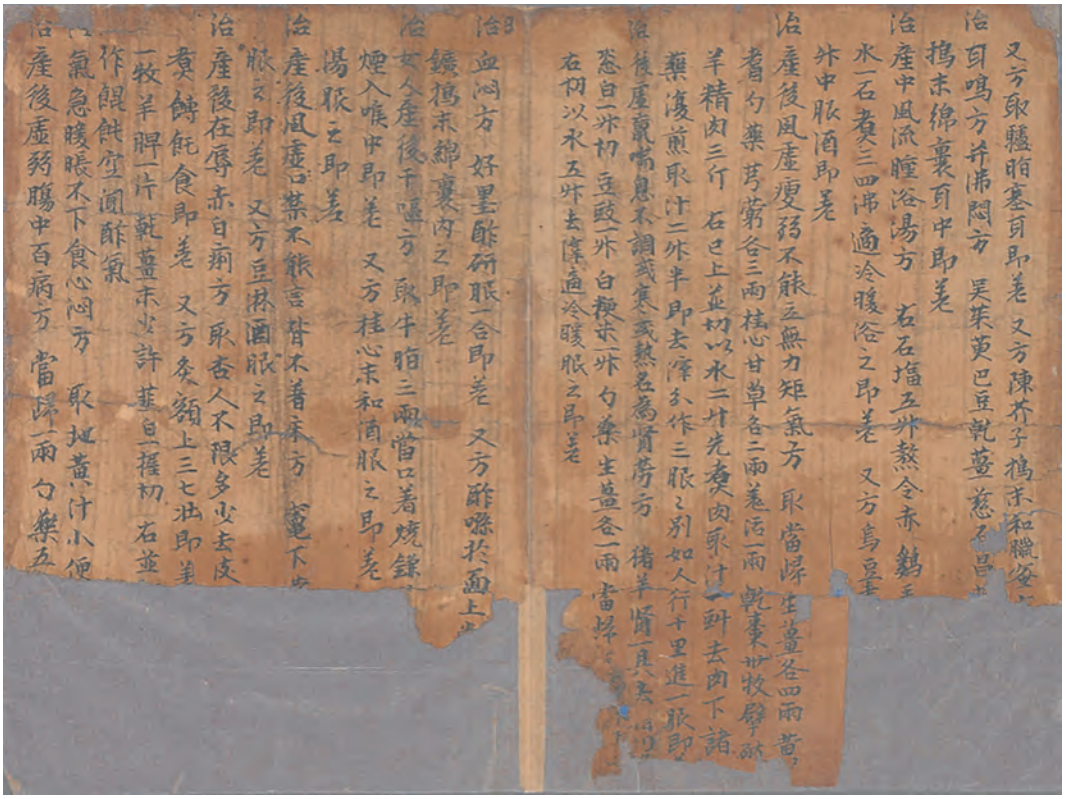

Figure 6 Dunhuang medical literature No. P.3930, *Dun Huang Chan Hou Feng Xu Shou Ruo Fang*, lines 7–10 (source with permission from: National Library of China, Chinese Ancient Texts Resource Database)

al. [76] found that *Dun Huang Chan Hou Feng Xu Shou Ruo Fang* can reduce the expression of PI3K, AKt, COX-2 and VEGF in EMT dysmenorrhea rats ($p < 0.05$), and its mechanism may be related to regulating PI3K/Akt signaling pathway and then inhibiting the growth of ectopic endometrium.

It could also treat chronic heart failure (CHF). CHF leads to cardiomyocytes undergo necrosis, which will lead to the increase of CK and aspartate aminotransferase (AST).[77] Meanwhile, the pathogenesis of heart failure is related to oxidative stress and other factors, SOD can reduce oxidative stress, and MDA can reflect the degree of cellular oxidation.[15] Another study showed that reducing the release of TNF-α and IL-6 inflammatory mediators can also reduce the pathological damage of myocardial tissue.[78] Wu Guotai (吴国泰), et al.[79] found that *Dun Huang Chan Hou Feng Xu Shou Ruo Fang* can significantly reduce the expression of CK, AST, MDA, IL-6, TNF-α, and increase the level of SOD ($p < 0.05$, $p < 0.01$), suggesting that this prescription can treat CHF by protecting cardiomyocytes, blocking inflammatory response, and reducing oxidative stress.

Besides, this prescription has an protective effect of acute hypoxia. Hypoxia can cause damage to body function, structure, metabolism, morphology and other aspects, which is the key factor to cause many diseases. Animal models play an irreplaceable role in the study of hypoxia related diseases, among which normobaric hypoxia model and isoproterenol induced acute myocardial hypoxia model in mice are more commonly used,[80,81] and hypoxia survival time and respiratory maintenance time after decapitation are commonly used indicators for studying the hypoxia resistance activity of medicines.[82] Li Fang (李芳), et al.[83] found that *Dun Huang Chan Hou Feng Xu Shou Ruo Fang* can significantly prolong the average survival time of mice with normobaric hypoxia and hypoxia model induced by isoproterenol, and prolong the survival time of mice with acute decapitation and increase the number of mouth openings, indicating that the recipe has a certain protective effect on acute cerebral ischemia and hypoxia.

2.3.2 *Dun Huang Xia Yu Xue Fang (敦煌下瘀血方 Dunhuang Static Blood Removing Prescription)*

Dun Huang Xia Yu Xue Fang (敦煌下瘀血方 Dunhuang Static Blood Removing Prescription) comes from Dunhuang medical literature (No. P. 3596, line 167) (Fig. 7), which consists of *Tao Ren* (桃仁 Semen Persicae), *Da Huang* (大黄 Radix et Rhizoma Rhei), and *Gui Xin*. It is mainly used for the treatment of sequelae of pelvic inflammatory disease. The original text did not record the specific indications and effects, but recorded the administration methods as follows: "Boil the medicinal herbs in one liter of water, make a concentrated medicinal solution, and take the decoction warm in three divided doses (三味以水一升，煮取三合，分温三服)". This prescription can also be used as *Jiao Yao* (角药 triplet herbs). In cases of poor blood flow or blood stasis, the three ingredients can be added to the treatment regimen.

Sequelae of pelvic inflammatory disease (SPID) is a kind of infectious disease of the female upper genital tract that is mostly transformed from pelvic inflammatory disease without healing.[84] Inflammatory cytokines and signaling pathways are involved in the whole process of the disease. Tumor necrosis factor (TNF) can induce the release of other inflammatory factors

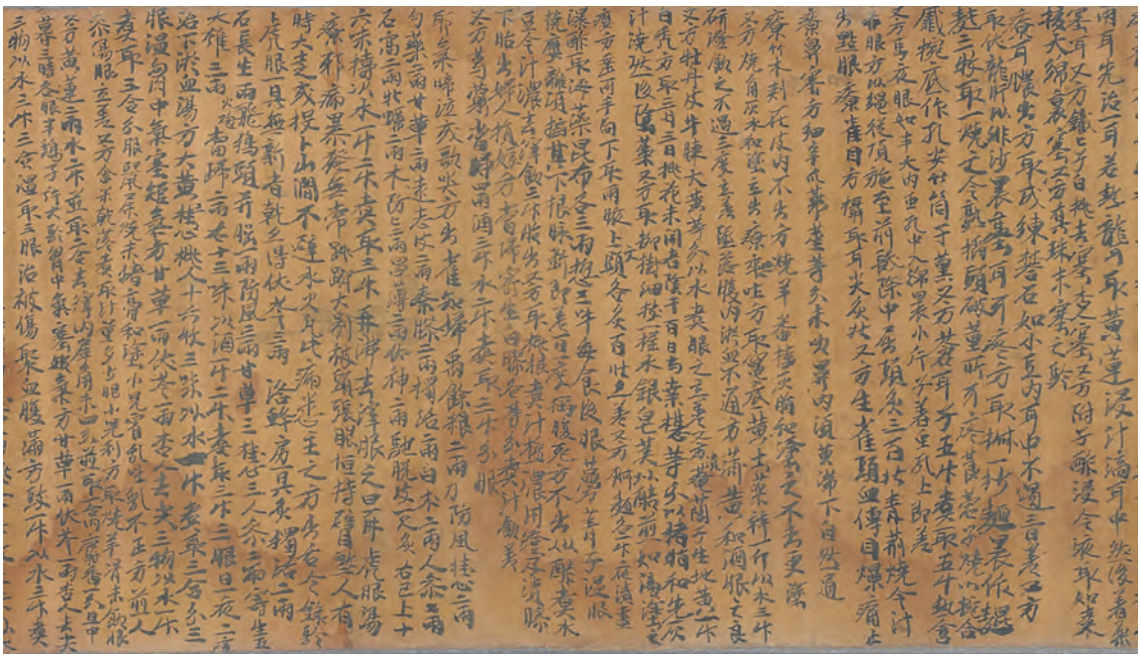

Figure 7 Dunhuang medical literature No.P.3596, *Dun Huang Xia Yu Xue Fang*, line 167 (source with permission from: National Library of China, Chinese Ancient Texts Resource Database)

(including IL-1, IL-6, IL-8, TNF-α itself) and aggravate the body's inflammatory injury.[85] IL-2 is closely related to immune function and participates in the body's antibody response.[86] Zhang Xiaohua, et al.[87,88] found that *Dun Huang Xia Yu Xue Fang* could reduce the levels of IL-6, IL-8, TNF-α, IL-1β and increase the level of IL-2 in SPID rats ($p < 0.01$ or $p < 0.05$), thus treating the sequelae of pelvic inflammatory disease.

2.4 Summary of experimental research progress

From the above summary and sorting, significant progress has been made in the experimental research of Dunhuang medical prescriptions. Through comparison and summary, we found that Dunhuang medical prescriptions have certain advantages in health preservation and prevention before illness, such as preventing and treating poisoning caused by chemical substances, reducing the side effects of Western medicine therapy and increasing efficacy, especially in anti-aging and other degenerative diseases. It is worth mentioning that gynecological medical prescriptions treat a wide range of diseases and can treat other types of diseases besides gynecological diseases, which is worthy of further in-depth research; Secondly, it can be found that Dunhuang medical prescriptions can treat various clinical diseases through multiple targets and pathways. In terms of experimental mechanisms, they can exert their effects through multiple pathways such as regulating oxidative stress, anti apoptosis, regulating metabolites and target proteins, and inhibiting inflammation.

At the same time, it is not difficult to identify the problems in the current experimental research on Dunhuang medical prescriptions, such as *Pi Sha Men Tian Wang Feng Xuan He Shang Shen Miao Bu Xin Wan* (毗沙门天王奉宣和尚神妙补心丸 Heart-tonifying Miraculous Pill of Vaisravana, the Heavenly King), *Dun Huang Bu Yi Zhuang Shen Fang* (敦煌补益壮身方 Dunhuang Body Tonifying and Strengthening Prescription), *Dun Huang Ba Gong Shen San* (敦煌八公神散 Dunhuang Eight Herbs Immortal Powder), *Dun Huang Liao Tan Yin Nei Xiao Fang* (敦煌疗痰饮内消方 Dunhuang Prescription for Eliminating Phlegm), etc., and there are blank areas in the research. Among the external prescriptions, *Dun Huang Xiao Bi Tong Ding* (敦煌消痹痛酊 Dunhuang Pain Relieving Tincture), *Dun Huang Yang Yan Mian Zhi* (敦煌养颜面脂 Dunhuang Facial Cream for Skin Rejuvenation), *Dun Huang Shen Min Bai Gao* (敦煌神明白膏 Dunhuang Divinity White Cream) are still in early research. Gynecological prescriptions, such as *Dun Huang Chan Hou Fu Tong Fang* (敦煌产后腹痛方 Dunhuang Postpartum Abdominal Pain Prescription), pediatric prescriptions, such as *Dun Huang Hai Er Leng Li Fang* (敦煌孩儿冷痢方 Dunhuang Prescription of Child Cold Dysentery), and andrology prescriptions, such as *Dun Huang Zhang Fu Shen Xu Wu Zi Fang* (敦煌丈夫肾虚无子方 Dunhuang Prescription of Men with Kidney Deficiency and Infertility) did not involve experimental studies.The research summary of Dunhuang medical prescriptions is presented (Table 1).

3 Transformation strategy analysis of Dunhuang medical prescriptions

As mentioned earlier, while there has been some progress in the experimental research of Dunhuang medical prescriptions, there is still a huge research gap, which makes it difficult for Dunhuang medical prescriptions to be used for clinical translation and to produce real results for treating clinical patients. Therefore, promoting the clinical translation of Dunhuang medical prescriptions is also one of the urgent issues that need to be addressed. The foundation of successful transformation lies in inheritance and innovation. Based on this, this article elaborates in detail on the transformation strategy of Dunhuang medical prescriptions, in order to provide reference for the future development of Dunhuang medical prescriptions.

3.1 Perpetuate inheritance according to essence

The culture of TCM in Dunhuang medicine is rich in health, scientific and technological innovation, economic construction, cultural and ecological values and resources,[89] and it plays an important role in improving people's health and benefiting patients. Therefore, it is very important to do a good job in the inheritance of Dunhuang medicine prescriptions, which not only helps to dig the connotation of Dunhuang medicine and fill the blank of Dunhuang TCM culture research, but also is the premise of Dunhuang medicine development and innovation. Therefore, the author proposes to carry out the correct inheritance of Dunhuang medicine from conducting in-depth research on Dunhuang medical prescriptions, inheriting the experience of famous doctors of Dunhuang medical school, and combining the development of science and technology with the use of informatization and digitization.

3.1.1 Deep excavation of Dunhuang medical prescriptions

In the inheritance of Dunhuang medicine, Dunhuang medical literature is an important information resource. These documents supplement the gap of medical literature in the Sui and Tang dynasties in the history of Chinese medicine, and have high academic research value.[90] In recent years, the classification, collation and research of Dunhuang medical literature have been preliminarily completed, and the research on some prescriptions has made some progress. However, there are still some deficiencies in the mining and exploration of some literatures and prescriptions, and the research tends to decline gradually. New arguments are rarely put forward, so the depth of some topics is insufficient.[91] At the same time,

Table 1 Summary table of Dunhuang medical prescription research

Classification	Prescription	Composition	Provenance and ancient application	Indications	Mechanism of action
Medical prescriptions related to internal medicine and health preservation	*Dun Huang Si Shi Chang Fu Fang*	*Tu Si Zi, Fu Shen, Ren Shen, Yuan Zhi, Gui Xin*	No. P.2565	Prevent and control cadmium poisoning	Reduce oxidative stress damage and regulate cytokines Regulate metabolic products Antagonistic lipid peroxidation of cadmium Improve liver oxidative damage Antagonize cadmium-induced lipid peroxidation
				Improve Alzheimer's cognitive status	Regulate target proteins
	Dun Huang Ping Wei Wan	*Shu Da Huang, Dang Gui, Zhe Chong, Fang Feng, Shu Fu Zi, Gan Jiang, Ren Shen, Gao Ben, Xuan Shen, Ku Shen, Jie Geng*	No. P. 3287 Treat sub heart pain and a sense of suspension, hunger but not wanting to eat	Anti-tumor	Mediate apoptosis Regulate the PI3K/Akt/mTOR signaling pathway Downregulation of Notch signaling pathway
				Relieve intestinal mucositis caused by cisplatin	Increase barrier-related factors to inhibit inflammation
	Dun Huang Shen Xian Zhou	*Shan Yao, Qian Shi, Jing Mi, Jiu Cai Zi*	No. P.3810 Replenish weakness and fatigue, nourish qi and strengthen the mind, strengthen initial yang qi, stop diarrhea, and bring joy spirit	Prevent and treat radiation-induced brain injury	Regulate the GSK-3β/Nrf2 signaling pathway to resist oxidative stress
				Palliate Alzheimer's disease and anti-aging	Inhibit cell apoptosis Reduce oxidative stress and inhibit cell apoptosis
	Dun Huang Gu Ben Fang	*Ren Shen, Huang Qi, Bai Zhu, Min Dang Gui, Chen Pi, Ma Lu Rong*	Modified from the Dunhuang ancient medical prescription *Fu Shen Tang* Treat weakness after exposure to wind, smooth and swollen pulse, itchy and hard neck, unstable qi in the heart, and inability to eat	Treat irritable bowel syndrome (IBS)	Reduce mast cells and tryptase; Regulate target proteins to alleviate inflammatory response
				Relieve exercise-induced fatigue	Improve myocardial energy supply and protect against myocardial damage
Medical prescription for external use	*Dun Huang Rui Cao Gao*	*Rui Cao, Fu Zi, Dan Shen, Xi Xin, Dang Gui, Hua Jiao, Wu Zhu Yu, Bai Zhi, Zhi Zhu, Sheng Ma, Gui Xin, Niu Su, Bai Zhu, Shui Niu Jiao, Qing Mu Xiang, Ding Xiang, Ling Ling, Dang Lu*	No.P.3731 Treat various foot swelling caused by wind toxins, ulcers, Yin Zhen (urticaria), severe ulcers, limb stiffness and inability to move independently	Treat knee osteoarthritis	Inhibiting the p38 MAPK signaling pathway to suppress cartilage matrix degradation
				Prevent and treat Yin Zhen	Inhibit the PI3K/AKt signaling pathway
				Treat frostbite	Regulate the TLR4/MyD88/NF-κB signaling pathway to promote vascular endothelial proliferation and differentiation
Gynecology related medical prescriptions	*Dun Huang Chan Hou Feng Xu Shou Ruo Fang*	*Dang Gui, Sheng Jiang, Huang Qi, Shao Yao, Chuan Xiong, Gui Xin), Gan Cao, Qiang Huo, Gan Zao, Yang Jing Rou*	No.P.3930 Treat postpartum weakness due to wind, inability to stand, lack of strength, and shortness of breath	Treat polycystic ovary syndrome - ovarian fibrosis	Reduce fibrosis factors, Regulate the HIF-1α/VEGF signaling pathway
				Treat Endometriosis Dysmenorrhea	Regulate the PI3K/AKt signaling pathway
				Treat chronic heart failure	Protect myocardial cells, reduce inflammatory response and oxidative stress
				Protective effect of acute hypoxia	Extend survival time and increase the frequency of mouth opening
	Dun Huang Xia Yu Xue Fang	*Tao Ren, Da Huang, Gui Xin*	No.P.3596	Treat sequelae of pelvic inflammatory disease	Reduce inflammatory factors

it is also an important direction of Dunhuang medical literature research to further explore the cultural connotation of Dunhuang TCM to fill the research gap.[89] Therefore, it is necessary to explore the breadth and depth of Dunhuang medical prescriptions more targetedly, and conduct in-depth research on Dunhuang medical prescriptions on the basis of adhering to the original literature.

3.1.2 Experience inheritance of famous doctors of Dunhuang medical school

The academic thought and clinical experience of famous TCM doctors are the essence and carrier of TCM knowledge.[92] "Dunhuang medical school" refers to the academic proposition and clinical thinking of its own school formed in the process of studying and inheriting Dunhuang medicine.[93] Therefore, it is urgent to collect and sort out the academic thoughts and clinical experience of the famous TCM practitioners of Dunhuang medical school. Collecting and sorting out recent clinical cases, ensuring the collection of original data and verifying its authenticity of data are helpful. The representative figures of Dunhuang medical school, such as professor Wang Daokun (王道坤) and Professor Li Yingcun, have in-depth study on their medical activities, clinical experience, proven prescriptions and cases, and works, so as to summarize the common experience and personalized medication suitable for clinical practice, so as to better inherit the clinical practice of Dunhuang medicine prescriptions. At the same time, the theoretical system of Dunhuang medicine prescriptions should be organized, so as to lay the foundation for the innovation and develop ment of later scholars.

3.1.3 Informatization and digital inheritance

Make full use of modern information technology to systematize and digitize Dunhuang medical prescriptions and clinical research, and use the database as the carrier and the network as the way of communication to achieve rapid, extensive and effective communication. Data mining provides an objective path for the discovery of academic thoughts, experience summary and tacit knowledge rules of famous TCM practitioners, and has great value in discovering, improving and reconstructing the algorithms and models for their diagnosis and treatment of diseases.[94] Therefore, by fully utilizing technological means such as information technology data mining, clustering analysis, association rules, Bayesian network analysis, as well as analysis of medicines syndrome/symptom patterns, core prescription analysis, and medication compatibility patterns related to the commonly used prescriptions of famous doctors in Dunhuang medical school are conducted. At the same time, emerging artificial intelligence (AI) technologies such as TCM diagnosis and treatment big data intelligent analysis system, AI software ChatGPT,[95] DeepSeek, etc. are used to assist in the establishment of the database.Through the establishment of a database, the Dunhuang medical content is coded, and the Dunhuang medical clinical case knowledge base is constructed, so as to realize the inheritance of high-tech applications in the Dunhuang medical prescription field.

3.2 Innovation and development

In order to realize the development idea of Dunhuang medicine "Going out of the collection and into the classroom, out of the classics and into practice, out of the country and into the world", innovative development under the premise of inheritance should be carried out. In terms of experimental research, we should further explore the mechanism of Dunhuang medical prescriptions, closely follow the hot topics of international scientific research, innovate the timeliness and novelty of research, and reduce repetitive research. From a new perspective to explore the ancient prescription. In terms of clinical application, the combination of Dunhuang ancient medical prescriptions with modern research and the addition and subtraction of the original prescriptions to make them more suitable for clinical practice are also one aspect of its clinical innovation. For example, *Dun Huang Shi Shi Da Bao Jiao Nang* (敦煌石室大宝胶囊 Dunhuang Stone Chamber Treasure Capsule) were modified by Professor Wang Daokun of Dunhuang Medical School, who combined Taoist health preservation prescriptions and clinical experience from Dunhuang medical literature. It is composed of *Shu Di* (熟地 Radix Rehmanniae Praeparata), *Huang Qi*, *Dang Gui*, *Fu Ling* (茯苓 Poria), *Da Huang*, *San Qi* (三七 Radix et Rhizoma Notoginseng) and other medicines. The animal experiment proved that it has the effect of improving brain function and delaying aging.[96] This shows that innovative development serves as a crucial driving force for the further promotion and transformation of Dunhuang medicine.

3.3 Analysis of transformation approach

The concept of translational medicine, born in the early 21st century, has become a hotspot and focus of medical research globally since its inception, and it is still thriving.[97] Its research model is "from laboratory to clinical", which involves efficiently and rapidly applying the results of laboratory basic research to clinical practice, thereby closely integrating scientific research with clinical practice. The ancient medical prescriptions of Dunhuang have made great contributions to safeguarding the people in the region. If they can be incorporated into the research model of translational medicine based on their own advantages, a virtuous feedback loop of basic research, scientific research, and clinical application can be achieved through "clinical–laboratory–clinical". To

maximize the value of the ancient medical prescriptions of Dunhuang, it is necessary to leverage the development model of translational medicine. This will enable new breakthroughs and progress, and promote the comprehensive, coordinated, and sustainable development of Dunhuang's TCM culture.[98]

3.3.1 Transformation of teaching and education

The enlightenment of the concept of translational medicine for teaching is "from classroom to clinical practice", so the final result of the transformation of medical teaching is the clinical level of students.[99] Similarly, under the guidance of the concept of translational medicine, the core of the teaching purpose is talent training.[97] In view of the serious disconnection between basic disciplines and clinical applications, which affects the cultivation of medical talents, it is urgent to explore a teaching path to "transform" Dunhuang medical research results into clinical practice. The final transformation achievement of Dunhuang medicine in teaching and education should be the ability of students to use Dunhuang medical prescriptions in clinical practice. For the cultivation of such talents, the cooperation between schools and hospitals should be strengthened.[89] On the one hand, teachers who use Dunhuang medical prescriptions in clinical practice will be introduced into the classroom to help cultivate talents by hiring senior Dunhuang medical specialists to give lectures or hold forums. On the other hand, guided by clinical needs, the main efficacy of Dunhuang medical prescriptions should be publicized in the corresponding departments or by participating in high-level academic exchanges, so that Dunhuang medical prescriptions can take root in clinical practice.

3.3.2 Transformation of clinical application

The central idea of translational medicine is still to solve clinical problems, but for a long time, only a small part of basic research has been used in clinic.[100] For a long time, one of the main lines of the development of TCM is to realize the mutual transformation between basic research and clinical practice.[101] Therefore, the clinical application and transformation of Dunhuang medicine is also the top priority in the development of Dunhuang medicine. Not only should Dunhuang medical specialist clinics be established in corresponding hospitals, but community health services are also covered by translational medicine.[102] Dunhuang medicine covers the content of "treating diseases before they become ill" in TCM. It promotes and applies the health care and disease prevention, disease prevention, tonic diet and dietotherapy in Dunhuang medical prescriptions, sinks to the grass-roots level, helps improve the grass-roots service ability of Dunhuang medical prescriptions, and expands the influence of Dunhuang medical prescriptions.

3.3.3 Transformation of achievements and products

Translational medicine is an important way for the development of medicine in the 21st century. Its core is to transform the research results of basic scientific research into clinical methods and medicines.[103] In view of the low conversion rate of medical scientific and technological achievements in China, the ability to transform achievements into industries is insufficient.[104] The integration of TCM and translational medicine has been opened up, which will provide strong help for accelerating the development of new TCM medicines in clinic.[101] Dunhuang medicine has great potential for achievement transformation because of its rich content and wide coverage. Therefore, promoting the achievement product transformation of Dunhuang medical research is one of the tasks of Dunhuang medical development. Researchers often focus on applying for various funded projects to produce papers and other results, but they do not meet the needs of clinical patients. The development of traditional Chinese patent medicines and simple preparations based on Dunhuang medical prescriptions is the product of combining basic research with clinical needs,and are an important bridge connecting the basic research and clinical practice of Dunhuang medicine. Therefore, the Dunhuang characteristic medical prescriptions and therapies will be transformed into clinical practical products and technologies, which will provide new ideas for the transformation of Dunhuang medical achievements. For example, *Dun Huang Shi Shi Da Bao Jiao Nang* mentioned above can protect intellectual property rights through patent application, and develop hospital preparations and clinical new medicines through clinical trials, real-world research, etc.

3.3.4 Transformation of interdisciplinary collaboration

Translational medicine is an interdisciplinary subject, which can be integrated with medical engineering, life science, social science, natural science and engineering technology. Based on the rapid development of molecular biology, proteomics, genomics, immunohistochemistry and other bioinformatics disciplines, the development of translational medicine and translational TCM has ushered in an opportunity of the times. With the progress of information technology, artificial intelligence has infiltrated into the field of TCM, providing more technical means for the modernization of TCM. By using the superior mechanism of continuous updating of artificial intelligence, combined with Dunhuang medical literature and the current situation of Dunhuang medical prescriptions research, the application value of Dunhuang TCM has been continuously strengthened by using large language model, multimodal integration and other technologies,[105] to contribute wisdom to the interdisciplinary transformation of Dunhuang medicine.

4 Conclusion

Significant achievements in experimental research and clinical application have been made on Dunhuang medicine prescriptions in recent years, verifying that this ancient medical system still has strong vitality and vigor. Notably, the contribution of Dunhuang formulas lies in their potential to address age-related diseases through a multi-targeted and multi-pathway approach. This makes them particularly relevant for preventing and treating various conditions associated with societal aging, showcasing broad application prospects. Moreover, there are still many blank areas in current research, and there is a lot of room for improvement, indicating its practical and research value. At the same time, through review and summary, we are also aware that there are still many shortcomings in the experimental excavation and clinical verification of Dunhuang medical prescriptions. At the same time, the inheritance, innovation, and achievement conversion rate of research are seriously insufficient. Therefore, in order to promote the further development of Dunhuang medicine prescriptions, it is necessary to thoroughly improve the research deficiencies. Simultaneously, it should embody the principles of translational medicine. On the basis of inheritance and innovation, through the transformation strategy of teaching and education, clinical promotion, product transformation, and multidisciplinary integration, it should better combine research results with clinical practice, and make Dunhuang medicine become a healthcare achievement that benefits all mankind in the context of "the Belt and Road" era.

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Ethical approval

This study does not contain any studies with human or animal subjects performed by any of the authors.

Author contributions

DONG Xiaofei prepared, created and/or presented the published work, specifically wrote the initial draft (including substantive translation), and performed the visualization/data presentation. YANG Xiaoyi prepared, created and/or presented the published work by those from the original research group, specifically critically reviewed, commented on or revised the manuscript including pre- or post-publication stages. LI Yingcun managed and coordinated the research activity planning and execution, and acquired the financial support for the project leading to this publication.

Conflicts of interest

The authors declare no financial or other conflicts of interest.

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History and Cultural Comparisons between African and Traditional Chinese Medicine: The Case of Tetraena Gaetula

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Abstract

African traditional medicine is characterized by its rich ethnobotanical heritage, diverse healing practices, and the integration of different culture influences. Similarly, traditional Chinese medicine (TCM) is deeply rooted in ancient philosophies, emphasizing balance, holistic diagnostics, and herbal formulations. Despite their geographical distance, both systems share historical and cultural parallels, particularly in their therapeutic principles, use of natural remedies, and holistic approaches to health. Combining these two medical traditions would offer a comprehensive perspective on healing, particularly through herbal medicine, diagnostic methods, and variations in preparation techniques and applications. As an example, Tetraena gaetula is a perennial plant endemic to the arid and semi-arid regions of Morocco, widely used in local medicine to treat diabetes, dermatological conditions, and liver, kidney, and stomach ailments, as well as in veterinary care. The unique properties of Tetraena gaetula could enhance research on multi-faceted approaches of Chinese medicine including herbal methodologies and local applications, contributing to the development of innovative medicines or therapies that integrate the strengths of both traditions. This paper explores potential strategies for integrating African traditional medicine and TCM, highlighting both the opportunities—such as the potential for new medicine discoveries, expanded treatment options, and cross-cultural knowledge exchange—and the challenges, including differences in regulatory frameworks, scientific validation, and the preservation of traditional knowledge.

Keywords: Tetraena gaetula; Africa; African traditional medicine; Traditional Chinese medicine; Moroccan traditional medicine

1 Introduction

African traditional medicine is an ancient and diverse healing system deeply rooted in spiritual, cultural, and ecological connections. Practiced for centuries, it embodies a holistic healthcare system that combines the medicine of plants, rituals derived from spiritualities, and community-embedded practices.[1] Unlike conventional medicine, which often isolates specific symptoms or diseases, African traditional medicine emphasizes the interconnection between the physical, mental, and spiritual aspects of an individual's health. The use of natural substances, primarily derived from plants, is central to African traditional medicine but also includes animal and mineral entities as well.[2] This knowledge is carried on by other indigenous peoples, passing it down orally, generation after generation, and describing the therapeutic qualities of the native flora, which designates them as caretakers, just like it does for traditional healers.[3] Within those cultures, it is common to relate diseases as a physical manifestation of spiritual disharmony or dissatisfaction from ancestors. Therefore, healing practices will focus on rituals and offerings of protective charms to bring them back into spiritual alignment.[4] In all African regions, traditional healers are very resourceful and play a pivotal role in many spheres of the people's lives, such as counselors, social workers, psychotherapists, educators about traditional culture, cosmology, and spirituality, as well as custodians of indigenous knowledge systems.[4,5] In this matter, traditional medicine is an integrative part of the health institutions in Africa, as it also embodies cultural values, beliefs, and social structures. The integration of African traditional medicine reveals the endurance and innovative capacity to meet the health demands of varying populations across nations on the continent.[5]

As a fundamental component of African traditional medicine, plants have long served as primary sources of curative and preventive treatments, particularly in

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countries lacking financial resources and scientific knowledge.[3] The traditional use of medicinal plants is an ingrained aspect of the rich cultural heritage of African nations, as they hold the key to natural resources endowed with healing attributes. Such knowledge has been passed down through generations and is often not documented, but it stays vibrant in the memory of indigenous folks. These plants and their associated traditional practices are considered part of the cultural identity of the nations.[6] According to the World Health Organization (WHO), 80% of the world's population depends on traditional medical practices for some aspect of primary health care. In many of these developing countries and among ethnically different communities, plants provide medicines for almost all diseases.[7]

In a boarder context, Moroccan traditional medicine is a distinct branch of African traditional medicine, enriched by the country's unique cultural and historical influences. The use of plants for medical care in Morocco has been practiced since time immemorial. This practice is an important component of the Berber cultural heritage, which has traditionally played the role of a mediator between the indigenous people and nature.[3] The utilization of plant resources is closely linked to epidemiological, cultural, socio-economic status, and settlement factors. It is estimated that between 50 and 75% of the local population relies on traditional Moroccan remedies, which are based chiefly on endemic and indigenous plants.[8,9] Given that worldwide it has been often stated that around 35% of medicine products marketed originate from plants, and in contrast to Western scientific medicine, which relies more on chemicals, a plethora of studies have been performed in various regions with the only goal of testing these traditional handy culprits.[10] Exploration of ethno-resources becomes more essential and paramount in the scientific arena, especially in the medicinal plant room. The cultural practices associated with them contribute to the preservation of biodiversity and ecology. Thus, ethnobotanical studies of medicinal plants hold relevance both for the indigenous population and global society.[8,9] Documentation of indigenous knowledge with an emphasis on medically important plants will benefit pharmaceutical industries and researchers as a source of bioactive compounds.[6] These studies will direct attention towards the plants and their cultural practices linked to their use, persuading the need for their conservation. Such documentation will also guide researchers in selecting plants for pharmacological, toxicological, and phytochemical studies.[11] Taking Tetraena gaetula as a case study, an endemic plant of Morocco, its traditional medicament usages in dermatological conditions, diabetes treatment, and hepatic, renal, and gastric pain were presented in African documents, making it to be revered as a holy plant in traditional Moroccan medicine.[3,12] To understand the tradition, this article documents the cultural practices associated with Tetraena gaetula, showcasing the relevance of combining cultural teachings with traditional healing practices. The present study also lays a foundation for further understanding the cultural application and literature interaction between African and traditional Chinese medicine (TCM), giving possible integration strategies and addressing the opportunities that the fusion of these two medicines can provide as well as their challenges.

2 Historical interactions of traditional medicines between Africa and China: commonalities and differences

African traditional medicine and TCM are two of the oldest and most influential systems of healing in the world. Both have developed over millennia and are deeply embedded in their respective cultures.[13,14] While geographically distant, these systems share certain commonalities in their approach to health and healing, but they also exhibit distinct differences shaped by their unique cultural, environmental, and philosophical contexts.[15,16] The historical interactions between these two traditions, although limited in ancient times, have increasingly come into focus in the modern era, particularly as globalization and cross-cultural exchanges have intensified.

2.1 Integration of different cultures and philosophies

Within this broader context, Moroccan traditional medicine is a distinct branch of African traditional medicine, enriched by the country's unique cultural and historical influences, resulting in the integration of traditional medicine systems from various cultures, which enriches healthcare practices with plural health and healing approaches.[17] In this matter, Moroccan traditional medicine has its origins in Berber, Arab-Islamic, and African traditions, reflecting a complex tapestry of ethnomedical knowledge passed down through generations, while TCM was developed on many ancient foundations of Daoism, Confucianism, and centuries of empirical practice.[3,18,19] Therefore, both practices encompass a rich diversity of herbal remedies, spiritual healing techniques, dietary therapies, and manual therapies that address both physical and spiritual well-being. In Moroccan traditional medicine, Islamic faith greatly influences Moroccan folk medicine. Some healing practices combine certain verses from the Quran that they recite, prayers, and diverse rituals done in some shrines where there are localized saints popularly known as Marabouts. They demonstrate the complex intersection of religion and health in Moroccan society.[19] On a spiritual level, therapeutic rituals represent another key aspect of Moroccan traditional medicine, which often combine spiritual and physical healing. The Lila ceremony, conducted by Gnawa healers, is one example, in which music, dance, and prayer are used to address both mental and physical health issues, aiming

to restore emotional and spiritual balance.[3,19] As for TCM, an interesting aspect of its evolution is the role of *Zhu You* (祝由), which reflects how traditional healing practices were influenced by both regional folk beliefs and the rise of religious Daoism. The old southern *Zhu You*, known as the recipes of Yue, persisted despite shifts in philosophical paradigms and religious developments. Although the new rationale of *Zhu You*, aligned with Daoist cosmology, tended to diminish the significance of localized traditions, these regional practices continued to thrive.[18] Considering both the opportunities and challenges, the integration of traditional medicine systems from different cultures has the potential to enhance healthcare practices by combining their diverse healing approaches.

2.2 Common usage of herbal medicines and remedies

In Africa, herbal remedies are central to traditional healing practices. Commonly used herbs include rosemary, thyme, saffron, and various plants endemic to the region, such as Tetraena gaetula in Morocco. These medicinal plants are often used to treat digestive issues, respiratory conditions, skin ailments, immune system disorders, and cancer.[3,8,9] As for TCM, it employs a vast range of herbs, including ginseng, astragalus, licorice root, etc., which are used in various combinations to treat conditions by balancing yin (阴) and yang (阳) and promoting the flow of qi (气).[18,20] In this context, integrating the herbal knowledge from both systems could lead to the development of new, more effective herbal remedies. For example, combining the antioxidant-rich Moroccan herbs with Chinese herbs known for their immune-boosting properties may result in novel formulations for enhancing overall health and treating chronic conditions. Additionally, shared research on the pharmacological properties of these plants could validate traditional uses and discover new therapeutic applications.[21]

2.3 A holistic view to health and life preservation

Both African and TCM systems emphasize a holistic approach to health, viewing the body as a whole and considering the influence of lifestyle, environment, and spiritual factors. For example, Moroccan traditional medicine often integrates physical, mental, and spiritual health, with practices that include the use of herbal remedies, spiritual healing through Quranic recitations, and lifestyle adjustments such as dietary changes.[19] At the same time, TCM focuses on balancing the body's internal energies, particularly through the concepts of yin and yang and the flow of qi, using techniques such as acupuncture, herbal medicine, *Tui Na* (推拿) massage, and meditative exercises named *Qi Gong* (气功).[18,20,22] The holistic nature of the two systems made it possible for their philosophies to be combined and provide whole health solutions, covering physical, mental, emotional, psychological, and spiritual aspects.[23,24] For example, integrating the dietary wisdom of Moroccan traditional medicine with the energetic focus of TCM may offer balanced approaches to weight management, stress reduction, and chronic disease prevention.

However, the difference in cultural and philosophical foundations may also be one of the main challenges in merging these two systems, particularly in reconciling the spiritual elements with different religious and cultural contexts. Since it is rooted in Islamic beliefs, Moroccan medicine often intertwines healing with spiritual practices, including the use of Quranic verses and prayers. This system is also heavily influenced by Berber and African traditions, which incorporate animistic elements.[19] TCM is deeply influenced by Daoism, Confucianism, and Buddhism, with concepts such as yin, yang, and qi at its core.[18] In order to address the challenges raised by these philosophical differences, it is essential to promote cross-cultural understanding and respect for each system's unique philosophy.[25] Additionally, educational exchanges and collaborative research initiatives could help practitioners from both traditions learn from each other and find common ground to provide a neutral basis for integration.

2.4 Distinctive diagnostic methods and approaches

In terms of clinical assessment, each system has developed unique diagnostic methods that, when combined, could enhance the accuracy and effectiveness of diagnosis and treatment. In African traditional medicine, diagnosis often involves a combination of physical examination, patient history, and spiritual insight. Traditional healers may also use divination or spiritual consultations to identify the root cause of an illness.[19,26] As for TCM, the practitioners use systematic diagnostic techniques such as pulse diagnosis, tongue examination, and the assessment of qi, blood, and organ function to determine imbalances in the body.[27] Integrating African intuitive and spiritual diagnostic methods with the more systematic approaches of TCM may lead to a more comprehensive diagnostic process. This combination could be particularly useful in identifying psychosomatic illnesses or conditions with both physical and spiritual components, providing a fuller understanding of the patient's condition.

2.5 Different levels of integration with modern biomedicine

Both African traditional medicine and TCM have varying degrees of integration with modern healthcare systems, which could influence the potential for their combined application. For example, in Morocco, traditional medicine is widely practiced, especially in rural areas, but

its integration with the formal healthcare system is limited.[28] However, there are ongoing efforts to document and preserve traditional knowledge.[8,9,12] As for TCM, it is well integrated into China's healthcare system and is increasingly accepted in other parts of the world. TCM practitioners often work alongside Western medical doctors, providing a model for how traditional and modern medicine can coexist.[29,30] Following its introduction in China, Western medicine had a huge impact on concepts, diagnostics, treatments, and pedagogical methods of TCM.[31] Even in the West, TCM has been considered to be part of complementary and alternative medicine.[22] In this matter, developing frameworks for integrating Moroccan traditional medicine with TCM within modern healthcare settings would require collaboration with health authorities, traditional practitioners, and researchers.[32] Pilot programs could be established in regions where both practices are prevalent, allowing for the gradual introduction of combined therapies under professional supervision.

To sum up, emerging African traditional medicine and TCM may present a promising opportunity to enhancing healthcare practices by combining the strengths of both systems. Through the synergistic use of herbal medicine, holistic health approaches, and diagnostic techniques, a more comprehensive and culturally rich approach to health could be developed. However, successful integration requires careful consideration of cultural differences, regulatory challenges, and the need for scientific validation. By fostering cross-cultural collaboration and education, these two ancient systems of healing can contribute to a more diverse and effective global healthcare landscape.

3 Moroccan traditional medicine: history and cultural context

Moroccan traditional medicine is a distinct branch of African traditional medicine, enriched by the country's unique cultural and historical influences. Positioned at the crossroads of Africa, Europe, and the Middle East, Morocco has developed a medical tradition that blends Berber, Arab, and Andalusian practices, all within the framework of Islamic principles influenced by the country's diverse history and geographical position.[17] This medical system is characterized by a holistic approach that integrates not only phytotherapies and psychotherapeutic practices but also spiritual healing, physical therapies, and preventative measures. From the Mediterranean coastal regions to the dry Sahara, these diverse ecosystems in Morocco host a wealth of medicinal plants. These plants, which are used by traditional Moroccan healers, commonly known as Tabibs or Achab, have centuries of knowledge behind them and can treat many conditions.[3] Moreover, Islamic faith greatly influences Moroccan folk medicine. Some healing practices combine certain verses from the Quran that they recite, prayers, and diverse rituals done in some shrines where there are localized saints popularly known as Marabouts. They demonstrate the complex intersection of religion and health in Moroccan society.[19]

Plant-based remedies are central to Moroccan traditional medicine, particularly in treating ailments such as digestive issues, respiratory conditions, and mental health disorders like anxiety and depression. One of the most significant figures in this tradition is Ibn al-Baitar, an Andalusian botanist and pharmacist whose work in botany and pharmacology continues to influence Moroccan medicine (Fig. 1). In his book *Kitab al-Jami' fi al-Adwiya al-Mufrada* (*The Compendium of Simple Medicines*), he documented over 1,400 medicinal plants, many still used in contemporary Moroccan healing practices (Fig. 2).[17]Another pivotal contributor is Jamal Bellakhdar, whose research further bridges the historical and modern applications of botanical knowledge in Moroccan medicine. His studies emphasize the importance of conserving this traditional knowledge, which is integral to both historical and contemporary Moroccan healing practices.[3,6,26]

On a spiritual level, therapeutic rituals represent another key aspect of Moroccan traditional medicine, which often combine spiritual and physical healing. The Lila ceremony, conducted by Gnawa healers, is one example, in which music, dance, and prayer are used to address both mental and physical health issues, aiming to restore emotional and spiritual balance.[19] These practices highlight the important connection between the body and the spirit in Moroccan healing traditions.[23,24] In addition to psychotherapeutic practices, physical therapies are also a cornerstone of Moroccan traditional medicine. The Hammam, or steam bath, is one such practice used for both physical cleansing and therapeutic healing. The use of medicinal plants in the Hammam, such as Lavandula dentata (lavender) and Rosmarinus officinalis (rosemary), is common. These herbs are used for their anti-inflammatory, antiseptic, and soothing properties, promoting physical relaxation and detoxification.[3] Another important practice is cupping therapy (Hijama), which has been practiced in Morocco for centuries. This technique involves creating a vacuum in a

Figure 1 Portrait of Ibn al-Baitar (source with permission from: Wikipedia[33])

Figure 2 Front cover and a page of *The Compendium of Simple Medicines* (*Kitab al-Jami' fi al-Adwiya al-Mufrada*) (source with permission from: Wikipedia[33])

glass or bamboo cups, which are then placed on the skin to draw out impurities and stimulate blood flow. It is commonly used to improve circulation, relieve tension, and treat ailments such as muscular pain, digestive disorders, and headaches. Furthermore, massage therapies also play a significant role in Moroccan healing traditions. One well-known practice is the use of argan oil for skin and muscle treatments. The oil, extracted from the nuts of the argan tree, is used for its healing properties, such as reducing inflammation, treating skin conditions, and alleviating joint pain. The use of argan oil is widespread in both traditional medicine and modern cosmetic applications.[3]

As for preventive medicine, it is an essential element of Moroccan traditional practices, since Moroccan healers place a strong emphasis on maintaining health through dietary practices, lifestyle habits, and seasonal routines. Traditional Moroccan medicine often recommends specific foods and herbal remedies to balance the body's humors and prevent illness. Moroccan traditional medicine also intersects with culinary traditions. Many herbs and spices used in Moroccan cuisine, such as cumin, saffron, and ginger, are valued not only for their flavour but also for their therapeutic properties.[3,26]

4 A guide to Tetraena gaetula: token of traditional Moroccan medicine

Tetraena gaetula, formerly known as Zygophyllum gaetulum, is a perennial plant endemic to the arid and semi-arid regions of Morocco. Belonging to the Zygophyllaceae family, this species is well adapted to the harsh environmental conditions of the Sahara Desert and surrounding areas (Fig. 3).[34] In the context of Moroccan traditional medicine, Tetraena gaetula holds significant medicinal value, with a variety of therapeutic applications that have been passed down through generations.[3]

One of the primary traditional uses of Tetraena gaetula is its efficacy as a dermatological treatment against several skin diseases such as wound and burn healing.[3,36] The plant material is applied directly to cuts, wounds, and ulcers to promote faster healing. Traditional healers attribute the plant's effectiveness to its antimicrobial properties, which help prevent infections and support the natural healing process.[37] This practice is particularly valuable in remote regions where access to modern medical care is limited, making Tetraena gaetula a critical component of local healthcare practices.[36] Tetraena gaetula is also used in the treatment of eczema and various dermatoses. Its aerial parts are commonly used as a wash for body care and as cataplasm to treat breast cracks.[37] The antimicrobial properties of Tetraena gaetula extend its use to treating various skin infections and conditions. Infusions or decoctions prepared from the plant are used to cleanse infected areas, providing both antimicrobial action and symptomatic relief. This traditional use is especially pertinent in treating skin rashes, fungal infections, and other microbial-related skin disorders.[12,37,38]

In addition to its external applications, Tetraena gaetula is utilized in traditional medicine to address digestive issues. Infusions of the plant's leaves, stems, and roots are consumed to relieve stomach pain, improve digestion, and treat gastrointestinal disturbances by the Moroccan population, specifically in Guelmin and Terfaya regions.[3,36–38] This practice highlights the plant's versatility and its importance in maintaining overall digestive health within traditional Moroccan medicine.

Tetraena gaetula is also renowned for its application as an anti-inflammatory and anti-nociceptive agent. The plant's leaves and stems are traditionally crushed and made into a poultice, which is then applied to areas of the body experiencing inflammation or decocted and administered orally in cases of hepatic, renal, and gastric pain.[37,39,40] The anti-inflammatory properties of Tetraena gaetula are a cornerstone of its use against colds and ear infections within local communities in the Guelmim and Zagora regions.[37,39]

Another significant use of Tetraena gaetula is in the treatment of diabetes, hypertension, and cardiovascular

Figure 3 Pictures of Tetraena gaetula (source with permission from: *Flore et Végétation du Sahara*[35])

diseases. The plant decoct or infusion was traditionally used as hypoglycemic and hypotension agents.[37,41–43] Moreover, consuming an infusion is believed to tackle cardiovascular risk in African type 2 diabetes mellitus patients, providing them with considerable beneficial hypoglycemic, anti-oxidative, and anti-microbial effects.[44]

Beyond human health, Tetraena gaetula also plays a role in traditional veterinary medicine. Local herders use the plant to treat livestock for a range of conditions, including wounds, infections, and digestive issues. The use of Tetraena gaetula in animal care, such as camels, underscores its broad therapeutic potential in treating mastitis of bacterial origin with topical applications of plasters obtained by mixing oil or fat with the grinded aerial parts of the plant. However, fumigations are used as a prevention, disinfection, or treatment technique for secondary infections of salmonellosis and sarcoptic mange (a contagious skin disease characterized by crusty, pruritic dermatitis, and hair loss caused by mites of the family Sarcoptidae).[45]

To sum up, the medicinal uses of Tetraena gaetula holds cultural and ritual significance across different regions and communities in Morocco, reflecting the plant's embeddedness in the cultural fabric of Moroccan society (Table 1).

In addition, Tetraena gaetula usage has been referred to as an example of applying traditional knowledge based on environmental and biogeographical scopes in the ethnopharmacological field. The fact that the plant grows naturally in harsh conditions reflects its importance for maintaining the health of local people to some extent, especially in areas with little access to modern healthcare facilities.[50] The meshing of African traditional medicine, namely in Morocco, plays a complex and intricate backdrop to the economic, religious, and ecological fibre.[51] Tetraena gaetula can be considered the best example of why endemic plants play an important role in traditional medical systems and also indicates a deep relationship between people and their environmental surroundings.[50] With traditional medicine gaining traction on the global scene, it stands to reason that such practices are being protected and documented, so this know-how can contribute to contemporary healthcare solutions in a sustainable and culturally sensitive manner.

5 Pharmacological effects of Tetraena gaetula beyond traditional uses

While Tetraena gaetula has been traditionally utilized in Moroccan medicine for its anti-inflammatory, anti-nociceptive, antidiabetic, antispasmodic, antihypertensive, wound-healing, and antimicrobial properties,[3,37,39,43] recent pharmacological studies have uncovered additional effects that are not commonly recognized in traditional practices. These findings suggest that Tetraena gaetula possesses a broader spectrum of bioactive properties, which could have significant implications for modern medicine.

Preliminary studies have suggested that Tetraena gaetula exhibits strong antioxidant activity and may possess anticancer properties. Extracts of the plant have been

Table 1 Traditional uses of Tetraena gaetula in various regions of Morocco

Traditional Use	Disease Description	Plant Parts	Preparation	Administration
Antidiabetic[3,37–39,41–43,46]	Diabetes	Leaves, stems, and roots	Decoction or infusion	Oral
Antihypertensive[43,46,47]	Hypertension	Stems and leaves	Decoction or infusion	Oral
Anti-inflammatory[37,39]	Colds; ear infections	Leaves, stems, and roots	Decoction or powder	Oral and external use
Anti-nociceptive[3,37]	Local pain; stomach-aches; hepatic and renal pain	Leaves and stems	Decoction or powder	Oral and external use
Antiseptic[38,48]	Antiparasitic; anti-microbial	Leaves	Infusion	Topical
Antispasmodic[3,36–38]	Gastralgia; stomach-aches; gastrointestinal pain; spasms	Leaves, stems, and roots	Powder	Oral
Dermatological[3,12,36,37]	Eczema and various dermatoses; body care; breast cracks; boil; burn; wound; skin infection	Leaves, stems, and roots	Decoction, powder, juice, or infusion	Oral and external use as cataplasm or wash
Protective from cardiovascular diseases[43,44]	Antihypertensive; hypoglycaemic; anti-oxidative; anti-microbial (in type 2 diabetes mellitus patients)	Leaves	Infusion	Oral
Treatment of renal problems[40,49]	Kidney pain; pyelonephritis; bladder ailments	Leaves and seeds	Decoction	Oral
Veterinary conditions[45]	Camel diseases: sarcoptic mange; mastitis; salmonellosis	Aerial parts	Decoction or powder	Oral and external use

shown to inhibit the proliferation of certain cancer cell lines *in vitro*. This effect is thought to be related to the plant's ability to induce apoptosisin cancer cells, as well as its antioxidant properties that reduce oxidative damage caused by reactive oxygen species (ROS), which is a known contributor to cancer development.[52] Although this property is well-documented pharmacologically, it is not traditionally exploited in Moroccan medicine, where the focus has primarily been on the plant's anti-inflammatory and antimicrobial effects. However, further research is required to fully understand its mechanisms and applications.

Another significant pharmacological effect of Tetraena gaetula is its antidepressant effect. Studies have shown that the plant's protein extracts can protect mice from depression after the forced swimming manoeuvre.[53] This protective effect may be attributed to the tyrosine capacity to increase presynaptic activity, leading to an increased concentration of norepinephrine metabolites in the brainstem and decreased peripheral sympathetic outflow, which serves to contrast vessels and maintain blood pressure in times of stress.[54,55] However, this potential application is not traditionally utilized, and further studies are necessary to confirm its efficacy and safety in clinical settings.

Moreover, emerging evidence suggests that Tetraena gaetula has been shown to have hypocholesterolemic effects, indicating its potential use in managing cardiovascular diseases. In pharmacological studies, extracts of the plant have been observed to reduce hypercholesterolemia and oxidative stress induced by a high-cholesterol diet.[56] Then, a further study was aimed at investigating the effects of a lyophilized aqueous extract of Tetraena gaetula on erythrocyte lipid peroxidation and paraoxonase 1 (PON1) activity in rats fed a high-cholesterol diet. The results show that Tetraena gaetula extract induces a cholesterol-lowering effect but does not improve erythrocyte lipid peroxidation, despite the stimulation of antioxidant enzymes activities such as superoxide dismutase (SOD) and catalase (CAT), which was considered not enough in itself to protect red blood cells from the deleterious effects of ROS.[57] Despite these findings, the plant is not traditionally used in Moroccan medicine for the treatment of hypercholesterolemic patients, and its application in this context remains largely unexplored.

Those pharmacological effects are closely linked to the bioactive molecules that Tetraena gaetula contains, such as flavonoids of the flavone type, tropolone-nucleated alkaloids, and triterpenoid saponins, making it a valuable plant for medicinal applications.[52,53,58] As for the essential oils, Tetraena gaetula's leaves, fruits, stems, and roots showed that Caryophyllene E, Decanone, and Bornylacetate were the major compounds, whereas, for mineral composition, calcium and sodium values were very high in leaf samples.[59]

While the current body of research provides valuable insights into the biological properties and potential mechanisms of Tetraena gaetula, it is important to acknowledge a significant limitation: the absence of clinical studies. To date, existing data are derived exclusively from *in vitro* and *in vivo* laboratory studies, which, although informative, cannot fully establish the efficacy, safety, or appropriate dosage for human use. Laboratory studies provide foundational evidence of pharmacological effects, such as antioxidant, antidepressant, and hypocholesterolemic activities, but these findings must be validated in clinical settings to understand their real-world therapeutic potential.[52,53,56] Therefore, future

research should prioritize well-designed clinical trials to confirm the bioactivity and safety of Tetraena gaetula in humans. Such studies would enhance the clinical relevance of current findings and support the development of safe and effective therapeutic applications based on this plant.

Ethical considerations are fundamental to the research process, particularly in studies involving animal and human models. In reviewing the biological and therapeutic properties of Tetraena gaetula, we recognize the importance of adhering to ethical standards that ensure the humane treatment of animals and protect the rights and safety of human participants. For the animal studies discussed, the authors followed the general guidelines on the use of living animals in scientific investigations given by the Council of European Communities, and their protocols using rats were approved by the institutional committee on animal care and use of the University of Oran in Algeria, such as minimizing animal suffering, using the smallest possible number of animals, and employing alternative methods whenever feasible.[56] If future clinical trials are conducted, adherence to ethical guidelines, including informed consent, risk minimization, and ethical oversight by institutional review boards, will be essential to ensure the safety and well-being of human participants.[60] Upholding these ethical standards will strengthen research integrity on Tetraena gaetula and support its responsible development as a potential therapeutic agent.

6 Conclusion

6.1 The potential of integrating African traditional medicine and TCM

To sum up, the combination of African traditional medicine with TCM has a great perspective on perfect medical services, as much more capabilities can be achieved by combining power and efficiency. First, the comparison between the two systems reveals an integrated division that can be used to support a more multi-faceted and culturally diverse understanding of health through the thoughtful amalgamation of herbal medicine with holistic approaches to diagnostic practices. Combining these remedies may result in potent and synergistic effects with boarder therapeutic potential, and more personalized and comprehensive health regimes which may drive research into the pharmacological properties offering people an integrated approach to wellness. Moreover, the historical, cultural, and philosophical connections between these traditions could provide fertile ground for future research and practical applications. However, successful integration requires careful consideration of cultural differences, respect for traditional practices, and the ability to navigate regulatory challenges through rigorous scientific validation. Ultimately, the fusion of these ancient healing systems can enrich global healthcare by promoting intercultural cooperation, knowledge exchange, and the development of more comprehensive treatment modalities. Together, these systems have the potential to enhance the efficacy and cultural richness of medical treatments globally.

6.2 The role of Tetraena gaetula as a bridge for collaboration

A key example of this potential integration is the case of Tetraena gaetula, an endemic plant from Morocco that represents a potential focal point for such interaction, highlighting how traditional knowledge can be shared, documented, and possibly integrated across different cultural and medical systems. Tetraena gaetula is traditionally used as a multifunctional plant in Moroccan folk medicine to treat vast and varied therapeutic areas, from dermatological and wound cases to digestive, hepatic, and renal conditions, in addition to the local veterinary practice. This underscores the plant's significant role in the Moroccan community. The retention and exploration of plants such as Tetraena gaetula play a crucial role in protecting the culture. Ensuring to merge this plant with modern challenges involved in promoting other current medicines since this plant is rich in bioactive molecules found as a result of pharmacological exploration, which led to its main use in Moroccan traditional medicine. These findings reinforce the role of this plant in the context of modern therapeutic applications such as antioxidant, anticancer, anti-apoptotic, hypocholesterolemic, and antidepressant effects as evidenced primarily through *in vitro* and *in vivo* laboratory studies. These findings suggest potential applications in treating inflammatory and oxidative stress-related conditions. However, the current literature on this plant is not without limitations. The reviewed studies are laboratory-based, often with small sample sizes and methodological inconsistencies. Variations in study design, extraction methods, and assay conditions may influence the reproducibility of findings. Additionally, the studies are largely region-specific, which may introduce cultural biases regarding the plant's medicinal uses. These factors highlight the need for more rigorous, large-scale, and standardized studies to confirm the findings and evaluate the plant's clinical relevance. Future studies should focus on clinical trials to validate efficacy, determine appropriate dosing, and assess long-term safety. Besides, exploring the plant's mechanisms in more detail could aid in identifying specific bioactive compounds responsible for its therapeutic effects, paving the way for targeted applications. Standardized, cross-regional studies are also needed to provide more consistent and generalizable data.

6.3 Integrating modern research to validate the plant's efficacy

A more comprehensive understanding of Tetraena gaetula's mechanisms of action and therapeutic effects will be essential in advancing its clinical applications in integrative medicine as antidiabetic agent, anti-inflammatory and analgesic product, gastrointestinal remedy, mental health adjunct, cancer therapy, and antioxidant supplement. Nowadays, as the integration of traditional medical knowledge is poorly considered yet attracts more attention, Tetraena gaetula might become a potentially prioritized research topic in TCM. Its one-of-a-kind characteristics could enhance current Chinese herbal methodologies. One of the medicinal potentials opened up in Tetraena gaetula can be a subject for joint research among both Moroccan and Chinese scientists. The strategy could pave the way for the creation of novel drugs or other therapies that use powerful tools from each traditional medicine system.

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Ethical approval

This study does not contain any studies with human or animal subjects performed by any of the authors.

Author contributions

Omaima Boudaia and Amal El Hamsas El Youbi conceived the idea of the review. Omaima Boudaia and Zineb Sekkout surveyed the literature and drafted the manuscript. Amal El Hamsas El Youbi, Najat El Amrani, and Driss Radallah scrutinized and corrected the final version of the manuscript. All five authors approved the final version of the manuscript before submission.

Conflicts of interest

The authors declare no financial or other conflicts of interest.

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中医药文化（英文版）

Discovering the Bioactive Agents from Herbal Medicines Team Led by Professor Ge Guangbo

Professor Ge Guangbo (葛广波) joined Shanghai University of Traditional Chinese Medicine (上海中医药大学 , SHUTCM) as a full professor and vice dean of Institute of Interdisciplinary Integrative Medicine Research in 2017. In 2021, he served as executive vice dean of the Institute of Interdisciplinary Integrative Medicine Research at SHUTCM. He has been awarded the National Natural Science Fund for Excellent Young Scholars, the National Young Qihuang Scholar (青年岐黄学者), and the Shanghai Outstanding Academic Leader.

The team led by professor Ge Guangbo currently consists of 9 faculty members and over 40 students, including 5 professors and 4 associate professors. Current studies of the team are focused on the high-efficiency discovery and innovative applications of bioactive agents from herbal medicines. Over the past five years, this team has developed more than 30 novel methods for high-throughput screening and characterization of bioactive agents from herbal medicines, while more than 50 enzyme inhibitors/modulators have been reported by this team. This team has presided over 20 national research projects, including the National Key Research and Development Program of China, the National Natural Science Foundation of China (regional joint key projects and general program), as well as the research projects founded by Shanghai Science and Technology Committee. Several group members have been selected for talent programs such as the Youth Talent Support Program of the China Association for Science and Technology, Shanghai Oriental Talent Plan, the Postdoctoral Innovation Talent Support Program, and Shanghai Super Postdoctoral Program.

Professor Ge Guangbo has published more than 380 publications in scientific journals, including *Molecular Cancer, Angewandte Chemie International Edition, Journal of the American Chemical Society, Advanced Functional Materials, Small, Redox Biology, Biosensors and Bioelectronics,* and *Acta Pharmaceutica Sinica B.* He has also applied for more than 90 patents (including 12 international patents), and 40 of them have been authorized. In addition, he also participated in the compilation of 5 monographs in both Chinese and English. Professor Ge Guangbo is the editorial board member/young editorial board member for 10 international academic journals, including *Acta Pharmaceutica Sinica B, iMeta, Research, View, Journal of Pharmaceutical Analysis, Smart Molecules, Chinese Chemical Letters, Biosensors, Journal of Ethnopharmacology, Drug Metabolism and Disposition, Chinese Medicine, Chinese Journal of Natural Medicines, Chinese Herbal Medicines,* and *Chinese Medicine and Culture.* He has also been honored with the Chinese Pharmaceutical Association Yiling Biopharmaceutical Award for Young Scientists, the China Association of Chinese Medicine Young and Middle-aged Innovative Talent Award, the First Cohort Young Qihuang Scholar Award, and the Shanghai May Fourth Youth Medal.