

Upholding Fundamental Principles and Whole-Chain Integration: A Study on Sun Xiaosheng's Thoughts and Practices in the Industrialization of Traditional Chinese Medicine

Xiaosheng Sun^{1,3}, Zhixuan Ying^{2,3}, Weizhou Yuan^{2,3}, Peng Li^{2,3}, Yatao Sun^{2,3*}

¹Guangzhou University of Chinese Medicine, Guangzhou 510000, Guangdong, China

²Tongkang Life Science (Guangzhou) Co., Ltd., Guangzhou 510000, Guangdong, China

³Tongkang Guangdong Provincial Science and Technology Expert Workstation, Guangzhou 510000, Guangdong, China

**Author to whom correspondence should be addressed.*

Copyright: © 2026 Author(s). This is an open-access article distributed under the terms of the Creative Commons Attribution License (CC BY 4.0), permitting distribution and reproduction in any medium, provided the original work is cited.

Abstract: The industrialization of traditional Chinese medicine (TCM) is a defining proposition of the time for the inheritance and innovation of Chinese medicine. Professor Sun Xiaosheng, who has devoted over forty years to the TCM field, has developed a systematic and comprehensive framework of theories and practices for TCM industrialization. This paper systematically examines his concepts and practical approaches from multiple dimensions: the theoretical construction of a green sustainable development evaluation system; early exploration of GAP-compliant cultivation and the systematic development of understory Chinese medicinal materials; industrial research on both authentic medicinal materials and introduced overseas botanicals; in-depth advancement of modern pharmacological research on TCM active ingredients; industry-university-research platforms driving a collaborative innovation ecosystem; regional planning for health-preserving cultural tourism; and industrial policy research. The study reveals that Professor Sun's practices have evolved through three stages: from the cultivation source to whole-industry-chain integration, from experience-based inheritance to technology-empowered innovation, and from single products to the construction of an industrial ecosystem. The core ethos is "upholding fundamental principles while making innovations" — preserving the theoretical essence of TCM while creating modern industrial forms. This systematic pathway, spanning "from field to clinic, from classics to products, from introduction to localization, and from culture to industry," offers a model worthy of reference for the high-quality development of the TCM industry.

Keywords: Industrialization of traditional Chinese medicine; Sun Xiaosheng; Green sustainable development; GAP standardized cultivation; Industry-university-research collaboration; Homology of medicine and food

Online publication: September 16, 2026

1. Introduction

The traditional Chinese medicine (TCM) industry is an industrial sector within the national economy that engages in the production, operation, research, and related economic activities of healthcare products guided by TCM theories. It integrates agriculture, industry, and commerce, combining production, supply, and marketing, and forms a complete industrial chain with the cultivation of Chinese medicinal materials as its foundation, the TCM manufacturing industry as its mainstay, and TCM commerce as its link. A major obstacle to the global acceptance of TCM is the presence of international technical barriers to trade and green barriers. To overcome these barriers, it is imperative to strengthen the industry internally by enhancing the scientific and technological content and quality of products, improving the green and sustainable development capabilities of TCM enterprises, and coordinating economic, social, and ecological benefits ^[1].

Professor Sun Xiaosheng, former Vice President of Guangzhou University of Chinese Medicine, doctoral supervisor, expert enjoying the Special Government Allowance of the State Council, and nationally renowned veteran TCM expert, has been engaged in the theoretical exploration and practical innovation of TCM industrialization since the 1990s. In 1996, during his tenure as Deputy County Mayor of Deqing County, he began promoting the construction of planting bases for TCM industrialization, involving varieties such as *Morinda officinalis* (Bajitian), *Polygonum multiflorum* (Heshouwu), *Citrus medica* var. *sarcodactylis* (Foshou), and *Pogostemon cablin* (Guanghuoxiang). His work earned him the Agricultural Science and Technology Progress Award of Zhaoqing City, and he collaborated with Professor Cheng Huizhen from the Chinese Academy of Medical Sciences and Professor Xu Honghua from Guangzhou University of Chinese Medicine to establish the first batch of GAP (Good Agricultural Practice) bases for southern Chinese medicinal herbs. Over the subsequent thirty years, he has continuously deepened his work in TCM industrialization, constructing a comprehensive methodological system that spans from source planting to product development, from the introduction of overseas medicinal plants to the promotion of localized industrial transformation, and from academic research to industrial application. This paper systematically reviews and academically interprets Professor Sun's thoughts and practices on TCM industrialization, based on his published works, research reports, and practical achievements in industrialization.

2. Theoretical foundation: A green and sustainable development evaluation system for the TCM industry

2.1. Definition of the connotation of green and sustainable development

Professor Sun Xiaosheng defines the connotation of green and sustainable development for the TCM industry based on three premises: first, as a complete industrial system, the TCM industry should create products that meet the health needs of contemporary society with minimal material and energy consumption, while minimizing environmental impact; second, it should be a development that continuously increases its economic benefits and meets the needs of virtuous cycles; and third, it should be a self-driven development that can consciously and continuously improve production methods ^[1].

Integrating these three aspects, he articulates the green and sustainable development of the TCM industry as “a development that, while ensuring the supply of TCM resources and environmental quality and the services they provide, combines the inherent objective laws of the industry's own development with longterm development, enabling the industry to sustain itself over the long term along a healthy trajectory through endogenous capacity for sustained growth.” This definition elevates TCM industrialization from a

mere economic growth issue to a strategic level encompassing ecological ethics and social responsibility ^[2].

2.2. Principles of index system construction and systematic framework

Professor Sun Xiaosheng proposed that sustainable development indicators should not be a mere copy or accumulation of traditional statistical indicators, but rather an organic synthesis, refinement, elevation, and innovation of original indicators. To this end, he established seven construction principles: facilitating the formation of an independent green innovation mechanism; providing a scientific basis for highlevel corporate decisionmaking; characterizing the greenness and intensive management level of the industry; promoting coordinated interaction between enterprises, society, and communities; driving the industry to align with international standards; embodying a combination of dynamism and stability; and achieving an organic unity of qualitative description and quantitative assessment.

On this basis, he planned to construct a green and sustainable development indicator system for the TCM industry from five aspects, and introduced the Analytic Hierarchy Process (AHP) to determine indicator weights, while establishing a comprehensive evaluation model using the fuzzy comprehensive decisionmaking principle. Through empirical analysis of TCM manufacturing enterprises in Guangdong Province, the scientific validity and operability of the model were verified. This research provides a quantifiable management tool for the green transformation of TCM enterprises, turning sustainable development from a concept into a measurable and assessable systematic method ^[3–4].

2.3. The “lifecycle” environmental management concept

Professor Sun particularly emphasized environmental management throughout processes, activities, and product life cycles, advocating that “without reducing the quality and functionality of enterprise products, the negative environmental impact of products throughout their entire life cycle should be minimized, and maximum profit should be achieved while ensuring the highest resource utilization rate and maintaining environmental quality.” This concept reflects a systematic examination of the entire TCM industry chain—from cultivation, processing, and distribution to use—and laid the theoretical foundation for subsequent GAP base construction and integrated industrial chain development. This research was included in the 2009 research project and investigation results compilation of the MunicipalandDepartmentLevel Training Class of the Party School of the Guangdong Provincial Committee of the Communist Party of China, titled “Implementing the Scientific Outlook on Development and Strengthening the TCM Industry Chain — Countermeasures and Suggestions for the Development of Guangdong’s TCM Industry,” was recognized as one of the outstanding achievements of the Party School through expert appraisal.

3. Source control: Early exploration and systematic development of GAP standardized cultivation and underforest TCM industry

3.1. Deqing County assignment and construction of the first batch of GAP southern medicine bases

In 1996, during his tenure as Deputy County Mayor of Deqing County, Professor Sun systematically promoted the construction of planting bases for TCM industrialization. Deqing County is an important production area for genuine medicinal materials in Guangdong, rich in varieties such as *Morinda officinalis*, *Polygonum multiflorum*, *Citrus medica* var. *sarcodactylis*, and *Pogostemon cablin*. Together with

his team, he went deep into the fields, organized farmers to conduct standardized cultivation experiments, and collaborated with Professor Cheng Huizhen from the Chinese Academy of Medical Sciences and Professor Xu Honghua from Guangzhou University of Chinese Medicine to establish the first batch of Good Agricultural Practice (GAP) bases for southern Chinese medicinal herbs. He also cooperated with Professor Chen Xigu from Sun Yatsen University of Medical Sciences to study the hypolipidemic and antiatherosclerotic mechanisms of *Polygonum multiflorum* [5]. The establishment of these GAP bases shifted the cultivation of genuine Guangdong medicinal materials from experiencebased to standardized practices, laying a material foundation for subsequent industrialization.

3.2. The “Ninth FiveYear Plan” national key science and technology project

The project “Research on Standardized Cultivation (GAP) of Five Chinese Medicinal Materials including *Amomum villosum*” was a key national science and technology project during the “Ninth FiveYear Plan” period. It established standardized cultivation research bases in Yangchun, Deqing, Guangzhou, and other locations for *Amomum villosum*, *Morinda officinalis*, *Pogostemon cablin*, *Citrus medica* var. *sarcodactylis*, and *Andrographis paniculata*. Guided by the “Good Agricultural Practice for Chinese Medicinal Materials,” the project systematically conducted research on all stages of production—preproduction, inproduction, and postproduction—covering ecological testing of production areas, species identification, variety breeding, cultivation management, pesticide residue and heavy metal control, determination of optimal harvest time and processing methods, and established quality evaluation systems and SOPs for each medicinal material. The project passed the acceptance by the Ministry of Science and Technology in 2002.

In addition, Professor Sun also promoted standardized cultivation research for genuine medicinal materials such as *Poria cocos*, *Gastrodia elata*, *Dioscorea opposita*, and *Ficus hirta* in the Fenghuang Mountain area of Chaozhou, exploring underforest threedimensional ecological planting models. In the Meizhou region, he focused on the industrial development of Lauraceae plants such as *Cinnamomum burmannii*—whose bark is an important raw material for Shuangliao Housan Powder (a proprietary Chinese medicine) and a source for extracting aromatic plant essential oils like borneol. He also cooperated with Shanghai Institute of Technology to research extraction processes and formulation compatibility of aromatic plant essential oils, providing technical support for the industrial development of aromatic plants in eastern Guangdong.

3.3. Underforest cultivation of Chinese medicinal herbs and exploration of threedimensional ecological agriculture for industrialization

Building on GAP standardized cultivation, Professor Sun’s team further extended the planting model from open fields to underforest threedimensional ecological systems. They systematically proposed an underforest TCM development model integrating “forest tourism and herbal healthcare,” using forest land resources as the foundation to form a “forest + medicinal herbs” threedimensional planting system. Underforest cultivation is a semiwild planting method; although yields are lower than field cultivation, the quality of medicinal materials is superior and ecological benefits are significant. The Huilai Southern Medicine Industrial Park is a typical case. The park utilizes idle lychee forests for multilayer ecological planting—the upper layer for lychees, the middle layer for simulatedwild *Dendrobium officinale*, and the ground layer for rhizomatous medicinal materials such as *Polygonatum sibiricum*, *Anoectochilus roxburghii*, *Pogostemon cablin*, and *Amomum villosum*. The park plans to build a 300mu (approx. 20 hectares) standardized seedling

center and establish 3,000mu (approx. 200 hectares) radiation bases in each of four surrounding towns, with the aim of driving farmer cultivation of approximately 20,000 mu (approx. 1,333 hectares) and developing 10 economically viable and qualitystable TCM varieties within five years.

3.4. The spring *Amomum villosum* Industry revitalization plan

Amomum villosum from Yangchun is a typical representative of genuine Guangdong medicinal materials, with high medicinal and economic value. However, traditional artificial pollination techniques are laborintensive and yield low productivity, leading to declining farmer interest and a continuous decrease in total annual production. In 2009, Guangzhou University of Chinese Medicine and the Yangchun Municipal Government formally signed a cooperation agreement to jointly implement the “Spring *Amomum villosum* Industry Revitalization Plan.” Professor Sun, then Deputy Party Secretary of Guangzhou University of Chinese Medicine, participated deeply as a core member. At the seminar, all parties agreed that the key to achieving high quality and high yield of *Amomum villosum* lies in increasing natural pollination rates through hightech means without relying on artificial pollination, while strengthening field management and standardizing cultivation techniques to reach the goal of high quality and high yield. After more than a decade of arduous scientific experimentation, the research team led by Dr. He Guozhen achieved breakthrough results at the Yangchun *Amomum villosum* experimental demonstration base, preliminarily overcoming the key technical challenges of natural pollination. The seminar also heard opinions and suggestions from industry representatives, including Guangdong Yipiantian Pharmaceutical Group and Guangdong Green Industry Group, as well as from veteran *Amomum villosum* farmers Lin Zhihan and Zhang Guangyan, forming a multiparty collaborative mechanism involving government guidance, university support, enterprise participation, and farmer cooperation.

3.5. Deep integration of cultivation with cultural tourism experience

Meizhou Yanminghu Tourism Resort is one of the first batch of “Guangdong TCM Culture and Health Tourism Demonstration Bases.” The resort invested nearly 6 million yuan to construct a standardized southern medicine cultivation and processing base, extensively planting over 300 medicinal species including *Cinnamomum burmannii*, *Osmanthus fragrans*, *Citrus medica* var. *sarcodactylis*, *Siraitia grosvenorii*, *Lonicera japonica*, and *Morinda officinalis*. In addition, it established the Lingnan Hundred Herbs Garden, which displays over 100 live specimens of southern medicinal herbs for tourists to view ^[6]. This model embodies the development approach of “promoting tourism through medicine and integrating medicine with tourism,” expanding the cultivation of genuine medicinal materials from a purely agricultural activity into a diversified industrial form encompassing cultivation, sightseeing, science education, and experiential activities.

In the planning of wellnessthemed towns, TCM cultural landscapes serve as important carriers highlighting the distinctive features of TCM. Themed areas for medicinal plant exhibitions and specimen displays of famous medicines can be created for tourist leisure and sightseeing; Chinese herbal medicines with ornamental value can be selected for green landscaping; and TCM cultural styles can be adopted in the decoration of buildings and facilities ^[7]. This approach extends TCM cultivation from farmlands to urban communities, integrating the “live display” of medicinal materials into everyday life settings.

4. Diversified development: Industrialization research on genuine medicinal materials and overseas herbal medicines

4.1. Multidimensional value exploration and wholechain development of Chenpi

Professor Sun Xiaosheng's research team conducted a systematic study on Chenpi (*Citri Reticulatae* Pericarpium) covering ancient texts, modern pharmacology, and cultural tourism integration, forming a wholechain development approach of "from classics to industry." First, the team used data mining techniques such as frequency statistics, association rule analysis, and cluster analysis to systematically investigate the application patterns of Chenpi in Linzheng Zhinan Yian (Clinical Guide to Medical Records), revealing the compatibility rules, dosage characteristics, and main syndrome distributions in Ye Tianshi's prescriptions, thus providing a literature basis for modern development of Chenpi ^[8]. On this foundation, the team further applied network pharmacology and molecular docking to identify active components, targets, and signaling pathways of Chenpi in treating fatty liver disease, demonstrating that flavonoids (e.g., hesperidin, nobiletin) exert hepatoprotective effects through multiple pathways regulating lipid metabolism, antiinflammation, and antioxidation ^[9]. Supported by these academic findings, Professor Sun also explored diversified development paths for the Chenpi industry from the perspective of cultural tourism integration, noting that Xinhui Chenpi in Guangdong has a history of nearly a thousand years and is a model of "medicinefood homology." He emphasized that its industrial development should not be confined to agricultural planting and medicinal material circulation, but should extend to cultural tourism, science education, and wellness experience. He proposed concrete suggestions such as building a Chenpi cultural museum, Chenpi wellness experience centers, and Chenpithemed rural tourism, extending the Chenpi industry from primary and secondary sectors to the tertiary sector, reflecting a systematic vision of the "whole industrial chain" ^[10-11]. Exploring modernization strategies for the "medicinefood homology" industry from the perspective of traditional Chinese medicine is of practical necessity ^[12].

4.2. Quality evaluation of Poria

Poria (*Poria cocos*) is one of the nine immortal herbs in the Daozang (Taoist Canon), and is both a commonly used medicinal material and a medicinefood homology variety. Under Professor Sun's guidance, Chen Ye conducted a systematic study of Poria from two dimensions: classical literature analysis and quality evaluation. Literature research revealed that in classic prescriptions throughout history, the frequency of Poria usage was second only to that of honeyfried licorice, with prescriptions containing Poria accounting for over 20% of the total; in healthpreserving works across dynasties, Poria was mentioned in 130 entries, covering soups, pills, ointments, boluses, powders, as well as congee, noodles, pastries, cakes, wine, and other dietary therapy forms. Analysis of Lingnan medical works identified three distinctive characteristics of Poria use by Lingnan practitioners: emphasizing diuretic dampnessdraining, strengthening the spleen and replenishing the middle, and calming the mind and soothing the spirit. In experimental studies, polysaccharide and pachymic acid contents of Poria samples from Guangdong were compared with those from Yunnan, Anhui, and Hubei; the quality of Guangdongproduced Poria was not inferior to that from the Daoproducing and main producing areas, and the fingerprint similarity exceeded 90%. This study improved the quality standards for Poria in the Chinese Pharmacopeia, provided scientific evidence for expanding Poria cultivation in Guangdong and strengthening research on Poriabased health products, and established content determination methods and fingerprinting techniques applicable for quality control in Poria industrialization ^[13].

4.3. Strategic considerations for the agarwood industry

Agarwood from western Guangdong is an important component of Maoming's industrial layout of "five trees, one fish, and one table of dishes." At a seminar on the culture and industrial development of western Guangdong agarwood, Professor Sun Xiaosheng systematically elaborated on the strategic positioning of the agarwood industry. He pointed out that agarwood has four major effects and serves five fields: orally, it benefits the digestive, circulatory, respiratory, and nervous systems; externally, it is used in rheumatism treatment, cosmetics, bath products, and health supplements. He emphasized that the agarwood industry should be appreciated from three perspectives: serving the national Healthy China strategy, building a strong province of traditional Chinese medicine, and boosting industrial quality. He particularly noted that while research on agarwood has yielded rich historical and cultural achievements, scientific and technological empowerment remains relatively weak, and the next step should be to "march toward science and technology." He also traced the history of agarwood in Sinoforeign cultural exchange—when the monk Jianzhen traveled to Japan, he brought 36 kinds of Chinese medicinal materials, among which was agarwood, providing cultural support for the international development of the agarwood industry.

4.4. Introductory research and industrialization assessment of *Melaleuca alternifolia*

Melaleuca alternifolia is native to Australia; its essential oil (tea tree oil) has broadspectrum antimicrobial activity and is widely used in medical and daily chemical fields. China introduced the plant to Huaiji County, Zhaoqing, Guangdong, in the early 1990s. Under Professor Sun's supervision, Wang Huifang conducted systematic research on the chemical composition, antimicrobial activity, and industrialization value of the introduced plant. GCMS analysis identified 90 compounds; compared with international standards, the Zhaoqing introduced variety was found to be neither the common 1,8cineole type nor the terpinen-4-ol type, but a hybrid intermediate between them. This quality variation may be related to local soil and climatic factors, directly affecting its industrial application direction. At safe concentrations, the essential oil samples showed no significant inhibition against several common pathogenic microorganisms, suggesting that this introduced variety should not be blindly industrialized in the traditional antimicrobial field. However, an important finding was that globulol combined with polymyxin produced a 128fold sensitization effect against *Acinetobacter baumannii* ($P < 0.05$); transcriptome sequencing indicated that the mechanism involved interference with ribosomal synthesis and benzoate degradation pathways^[14]. This discovery opened a new industrialization track for *Melaleuca alternifolia*—shifting from direct antimicrobial products to the development of antibiotic sensitizers. Professor Sun emphasized that the industrialization value of this research lies in clarifying the appropriate development direction for the introduced *Melaleuca alternifolia*, avoiding resource waste in ineffective areas, and reflecting a scientific attitude of "starting from reality and taking responsibility for the industry."

4.5. Introduction research on maca and localization of healthpreserving herbs

Maca (*Lepidium meyenii*) is native to Peru, is a medicinefood homology plant, and is known as "Peruvian ginseng." China successfully introduced it in 2002, and it was approved as a new resource food in 2011. Under Professor Sun's guidance, Wang Kai evaluated the ovaryprotective effects of imported and domestic maca using a kidneyyang deficiency rat model of premature ovarian failure. The results showed that the mediumdose group of imported maca had the best effect, significantly improving kidneyyang deficiency and promoting follicle development; domestic maca was also effective and had higher protein content,

indicating considerable development potential. Based on the natural properties of maca—shape, color, odor, taste, and harvesting season—the team proposed, for the first time, its nature, flavor, and meridian tropism as “pungent, sweet, slightly salty, warm; attributing to the spleen and kidney meridians,” and its actions as “warming and supplementing kidneyyang, strengthening the spleen and benefiting qi,” thereby filling a gap in the theoretical framework of maca in traditional Chinese medicine and providing a theoretical foundation for its industrialization^[15]. Professor Sun pointed out that current maca products generally lack TCM cultural connotations, and the core of industrialization lies in empowering product innovation with TCM theory. Accordingly, the team proposed a fourlevel development pathway: entering the household consumption market as a healthpromoting ingredient; driving the local economy through health tourism; covering subpopulations such as those with subhealth or pregnancy planning through dietary supplements; and elevating the industry through extraction of active components and new drug research and development. The core of this pathway is to upgrade maca from a simple agricultural raw material into a health product system with added TCM cultural value, avoiding homogeneous competition.

5. Technology empowerment: Deepening research on modern pharmacology of traditional Chinese medicines

5.1. Study on Curcumin combined with vitamin C against triplenegative breast cancer

Curcumin is the main active ingredient of *Curcuma* plants, widely found in commonly used Chinese medicines such as turmeric (*Curcuma longa*) and zedoary (*Curcuma zedoaria*). Under Professor Sun’s guidance, Ou Junwen conducted clinical and experimental studies on curcumin combined with vitamin C as adjuvant therapy for triplenegative breast cancer. A retrospective clinical study included 70 patients with advanced disease; the results showed that compared with chemotherapy alone, the combination group had no significant difference in shortterm response rate, but progressionfree survival and overall survival were significantly prolonged, and the incidence of adverse reactions was markedly reduced. In vitro experiments confirmed that the combination significantly inhibited cancer cell proliferation and induced apoptosis, with the mechanism involving regulation of the EGFR/PI3K/Akt pathway^[16]. Professor Sun pointed out that the industrialization value of this research lies in uncovering the application potential of curcumin, a traditional TCM active ingredient, in adjuvant cancer therapy—as a lowtoxicity, highly effective, orally available natural product, curcumin combined with vitamin C can serve as a chemosensitization and toxicityreduction adjuvant regimen, and has practical value for development into adjuvant therapeutic products, reflecting the translational application of the TCM principle “eliminating pathogens without damaging vital qi” in the oncology treatment industry.

5.2. Study on catalpol, an active ingredient of Rehmannia root

Rehmannia root (*Rehmannia glutinosa*) has been a key tonic herb for nourishing kidneyyin throughout history, and was listed as a topgrade herb in the Shennong Bencao Jing (Divine Husbandman’s Classic of Materia Medica). Under Professor Sun’s guidance, Lai Manxiang conducted a systematic study on the osteogenic differentiation mechanism of catalpol, an active ingredient of Rehmannia root. The study found that catalpol significantly promoted proliferation and osteogenic differentiation of bone marrow mesenchymal stem cells, with the mechanism related to upregulation of the Hedgehog signaling pathway^[17]. This study confirmed the scientific basis of the traditional efficacy of Rehmannia root in “tonifying the

kidney and dominating the bones” at the cellular and molecular levels, providing experimental evidence for the deep development and standardized quality control of this bulk medicinal material, and laying a theoretical foundation for the development of antiosteoporosis health products based on *Rehmannia* root active ingredients.

5.3. Mechanism research on analgesic Chinese medicines

Modern technology empowers the entire industrial chain of traditional Chinese medicine, not only preserving classic formulas and human use experience but also promoting innovation through quality control, mechanism research, and new drug development, comprehensively supporting TCM in serving people’s health ^[18]. Professor Sun’s team has long focused on modern pharmacological research on analgesic Chinese medicines. In the study of the analgesic mechanism of *Cynanchum paniculatum* (Xu Changqing), the team used pharmacological methods to systematically elucidate the scientific mechanism by which active ingredients such as paeonol regulate inflammatory mediators and affect pain conduction pathways to exert analgesic effects. In modern research on the “guide and envoy” action of borneol, the team applied modern pharmacokinetic methods to study the effect of borneol on bloodbrain barrier permeability and its mechanism of promoting other drugs to enter the brain, thereby providing a modern scientific interpretation for the traditional theory that “borneol guides drugs upward.”

5.4. Modern interpretation of the classic formula Fuzi Lizhong Tang

Fuzi Lizhong Tang, originating from the *Sanyin Ji Bingzheng Fanglun* (Treatise on Diseases and Syndromes from the Three Causes) of the Song dynasty, is a representative formula for warming the kidney and strengthening the spleen. Under Professor Sun’s guidance, Tan Weilu replicated a rat model of diarrheapredominant irritable bowel syndrome with spleenkidneyyang deficiency and explored its therapeutic mechanisms at the genetic and immunological levels. The results showed that Fuzi Lizhong Tang significantly improved diarrhea symptoms in model rats, reducing the Bristol stool form scale score, diarrhea rate, and diarrhea index ($P < 0.01$). Digital gene expression profiling identified 105 differentially expressed genes potentially related to its efficacy, and KEGG pathway enrichment analysis mainly involved immune pathways such as the intestinal IgA immune network ^[19]. This study revealed the scientific basis of Fuzi Lizhong Tang at the genetic and immunological levels, providing molecular evidence for the modern development and industrial promotion of classic formulas.

5.5. Systematic research on *Stauntonia chinensis*

Stauntonia chinensis (also known as Wuzhajianlong), a plant of the Lardizabalaceae family, was first recorded in the 1977 edition of the Chinese Pharmacopeia and reincluded in the 2010 edition. Its main components are pentacyclic triterpenoid saponins, with actions of dispelling wind, relieving pain, relaxing tendons, and activating collaterals. Clinically, it is used for trigeminal neuralgia, sciatica, and rheumatic joint pain, and has advantages such as no drug resistance, no addiction, and low toxicity ^[20]. Professor Sun’s team systematically summarized five major pharmacological actions of *Stauntonia chinensis*: analgesic and antiinflammatory effects, radiosensitizing effects, antitumor effects, anticomplement activity, and promotion of nerve cell growth. These studies provide scientific support for the transformation of *Stauntonia chinensis* from folk medicine to modern pharmaceuticals, and open new directions for the deep development of genuine medicinal materials in Guangdong.

5.6. Study on *Nicandra physaloides* extract and compound solid beverage with bird's nest

In recent years, Professor Sun's team has expanded research to the field of general health products. *Nicandra physaloides* has pharmacological actions including insecticidal, antitumor, antioxidant, antibacterial, diuretic, and hypoglycemic effects. Research on the chemical constituents of its fruit mainly includes steroids, flavonoids, alkaloids, and fatty acids ^[21]. Studies on the prevention of acute lung injury by *Nicandra physaloides* extract through remodeling immune metabolism have revealed its potential value in regulating immune responses and metabolic reprogramming, providing a new intervention strategy for the prevention of respiratory infectious diseases. Experimental research on the health benefits of a compound solid beverage with bird's nest systematically evaluated its health effects from perspectives such as immunomodulation, antioxidant activity, and antifatigue, providing experimental data for the transformation of bird's nest from traditional tonic to standardized functional food ^[22].

6. Industrial ecology: Industryuniversityresearch collaboration and platform construction

6.1. Development of Lingnan herbal beverages and medicinefood homology products

The Lingnan natural environment is characterized by “hot weather, thin poor soil, and heavy dampness near the sea.” The constitution of Lingnan people commonly presents as deficient fire rising in the cardiopulmonary region, dampness stagnation due to spleenstomach weakness, and colddampness predominance in the lower body ^[23]. “Research on key technologies for new product development of Lingnan herbal beverages and industrialization” is a collaborative project between the Ministry of Education and Guangdong Province, reflecting Professor Sun's systematic layout in transforming scientific and technological achievements. This project integrated the theoretical advantages of Guangzhou University of Chinese Medicine in Chinese herbal formulas with the industrial advantages of Guangdong food enterprises in production processes and market channels, developing a series of herbal beverage products with Lingnan characteristics. In the development of medicinefood homology products, Professor Sun established a clear research and development path: systematically designing from “classical TCM dietary therapy literature, combined with modern nutritional science, and enriched with TCM health preservation culture” ^[24–25]. He emphasized that the innovation direction for medicinefood homology products lies in dosage form upgrading—compared with traditional ointments, pills, and powders, modern products should shift to convenient forms such as beverages, tablets, granules, and powders, suitable for the daily healthpreserving scenarios of modern populations.

6.2. Construction of science and technology expert workstations

Professor Sun has used the Guangdong Provincial Science and Technology Expert Workstation as a hub to build a complete innovation chain covering basic research, technology development, product transformation, and talent cultivation. At the Guangdong Hengfu Pharmaceutical Co., Ltd. Science and Technology Expert Workstation, taking into account the characteristics of the Lingnan environment and geography—suitable for longgrowing herbs, mineral medicines, and marine medicinal materials—he guided the development of 32 specialty paste formulations, filling the gap in paste applications in western Guangdong ^[26]. He also promoted research on the medicinal and edible value of longan aril, and published the monograph *The Medicinal and Edible Value of Maoming Longan*. At the Tongkang Pharmaceutical Guangdong Provincial Science and

Technology Expert Workstation, he served as the leading expert, guiding the development of products such as “Cordyceps militarisPolygonatumGinseng tablets,” and promoting the integration of modern technologies such as directional enzymatic hydrolysis by Eurotium fungi with traditional formulas. The workstation is also preparing to build a CNAS laboratory, providing technical support for product quality control and standardized production.

6.3. Industrial policy research and strategic consulting

Professor Sun has actively participated in policy research and strategic consulting for the TCM industry. In 2009, he served as the lead writer of the research report Implementing the Scientific Outlook on Development, Strengthening the Traditional Chinese Medicine Industry Chain — Countermeasures and Suggestions for the Development of Guangdong’s TCM Industry for the Provincial Party School’s training class for leading cadres at the municipal and departmental level. After evaluation by experts from the Provincial Party Committee Organization Department, Propaganda Department, the Provincial Government Development Research Center, and the Provincial Party School, the report was recognized as one of the two outstanding achievements of the Provincial Party School and was included in the Compilation of Research Projects and Findings of the Provincial Party School. This report systematically analyzed the current situation, problems, and countermeasures of Guangdong’s TCM industry chain, providing important references for the formulation of industrial policies in the province.

He also led graduate students in the Philosophy of Science and Technology program at Guangzhou University of Chinese Medicine to conduct social practice surveys in the Zhaoqing Hightech Zone and other areas, writing investigation reports to gain an indepth understanding of the development status and needs of the TCM industry at the grassroots level. In addition, he participated in collaborative projects between Xinghu Technology and Fudan UniversityBosxing Fund, promoting deep integration of industry, academia, and research.

6.4. Popular science publishing and cultural communication

Professor Sun attaches great importance to the popularization and communication of TCM culture and the construction of academic exchange platforms. He published the bilingual (ChineseEnglish) book A Collection of Medicinal Plants, systematically introducing Chinese herbal medicine knowledge to international readers. He also published popular science works such as Tasting Herbal Medicine, disseminating herbal healthpreservation culture in an accessible manner. He has consecutively organized six “International Symposiums on Dietetic Therapy and Nutritional Health,” building an international academic exchange platform in the field of medicinefood homology and promoting the industrial transformation of research achievements in dietetic therapy. In terms of teaching system construction, he delivers the course Clinical Chinese Materia Medica for undergraduate students majoring in Chinese pharmacy, offers the graduate elective course Research on HealthPreserving Herbs, and has contributed to the compilation of several textbooks, among which Lingnan Chinese Materia Medica has been scheduled for publication by People’s Medical Publishing House.

6.5. International academic exchanges

Professor Sun actively conducts international academic exchanges and collaborations. He has visited the University of Bonn in Germany for academic exchanges, and at the 2017 International Botanical Congress

in Shenzhen, he exchanged views with Nobel laureate Ada Yonath on the application of natural antibiotics in TCM. He had previously discussed research ideas for treating erectile dysfunction by tonifying the kidney and activating blood circulation with Nobel laureate Fried Murad, known as the “father of Viagra.” He has delivered special lectures on topics such as The TCM Industry Chain and Economic Growth Points in multiple cadre training sessions in Guangdong Province, providing policy interpretation and strategic guidance for the development of the local TCM industry.

7. Wellness tourism and cultural tourism: Regional planning and industrial integration

7.1. Development concepts for wellness tourism at Yaowang Mountain in Tongchuan

Yaowang Mountain in Tongchuan is the longterm retreat of the renowned Tangdynasty physician and pharmacologist Sun Simiao, and it possesses exceptional natural and cultural resources for wellness tourism, particularly the legacy of “King of Medicine” Sun Simiao in medical and wellness culture. In his systematic research on Yaowang Mountain, Professor Sun proposed that the contributions and achievements of Sun Simiao in medical and wellness culture should be explored in depth, following a development approach that is “comprehensive, multiperspective, linking individual sites like beads on a string, and radiating nationwide.” Through the platform of tourism, the medical and wellness culture of “King of Medicine” Sun Simiao can be presented and disseminated to the whole country and even the world, thereby establishing a distinctive humanistic brand for wellness tourism in Tongchuan. This concept reflects Professor Sun’s consistent approach of transforming traditional Chinese medicine (TCM) cultural resources into advantages for the tourism industry.

7.2. Health and wellness industry planning in Huizhou and TCM cultural wellness tourism

Huizhou is one of the most promising regions in Guangdong Province for developing TCM cultural wellness tourism, benefiting from its favorable natural ecological environment and a strong wellnessoriented atmosphere. In 2014, Professor Sun was invited to participate in a consultative symposium on the development of the health and wellness industry in Huizhou, where he proposed that Luofu Mountain should serve as the core, and a “tourism + wellness” model be adopted to build a distinctive town for the broader health industry. Through the leading role of the wellness industry, the development of the entire industrial chain can be promoted, while local specialty products can be upgraded to highvalueadded Hakka cuisine, distinctive souvenirs, and industrial products. In terms of specific project design, the study proposed the construction of themed attractions such as the Ge Hong and Bao Gu Memorial Hall, an *Artemisia annua* (sweet wormwood) planting and ornamental garden, Bao Gu’s “Hongjiao Ai” (redfoot mugwort) zone, and Su Dongpo’s herbal garden, so as to fully tap into the TCM wellness cultural resources associated with historical figures such as Ge Hong and Su Dongpo. Regarding regional coordination, the study formulated a “vertical and horizontal alliance” strategy – vertically collaborating with Ge Hong’s hometown Jurong in Jiangsu, as well as Huangzhou, Danzhou, and Hangzhou, which bear traces of Su Dongpo’s activities; and horizontally cooperating with TCM cultural wellness tourism demonstration bases in Guangzhou, Shenzhen, and other cities, thereby generating a nationwide regional linkage effect^[27]. This planning provides a clear pathway for the differentiated development of Huizhou’s health and wellness industry.

7.3. Forest wellness tourism development

A study on forest wellness tourism development was conducted with Guangdong Province as the target area, and for the first time, a systematic framework for forest wellness theory was established. The study defines forest wellness as a comprehensive wellness approach based on forest environments and resources, employing environmental, behavioral, and spiritual wellness methods to achieve health maintenance and wellbeing. It summarizes four major principles: correspondence between nature and humans; treatment tailored to individual, seasonal, and local conditions; strengthening vital qi and avoiding pathogenic factors, with an emphasis on prevention; balancing dynamic and static activities while harmonizing body and mind; and comprehensive conditioning with sustained persistence. Ten specific methods were also identified: forest bathing, forestbased cuisine, forest exercise, forest hot springs, acupuncture and tuina, forest horticulture, forest meditation and spiritual practices, forest aromatherapy, forest music, and forest color therapy. Based on the distribution characteristics of forest resources in Guangdong Province, the study proposed six differentiated development models: underforest Chinese herbal medicine, ecogastronomy, leisure and fitness, health and wellness resort, mindcultivation resort, and mountainsea resort. This research translates forest wellness theory into operable industrial development plans, providing a systematic pathway for converting forest resources into a health and wellness industry ^[28].

8. Conclusions and implications

Professor Sun Xiaosheng's thinking and practice regarding the industrialization of Chinese medicinal materials can be summarized as a multidimensional systematic integration: the green and sustainable evaluation system provides a theoretical framework and quantitative tools; GAP standardized cultivation and underforest Chinese medicinal planting lay a highquality raw material foundation for the industrial chain; industrialization research on Daodi herbs and overseas botanicals opens up pathways from ancient text mining and pharmacological verification to culturaltourism integration and "bringing in" foreign resources; modern pharmacological research on Chinese medicines offers scientific interpretations of traditional empirical knowledge; industryuniversityresearch collaborative platforms establish a conversion channel from the laboratory to the market; industrial policy research provides academic support for government decisionmaking; and wellness and cultural tourism planning extends the Chinese medicinal industry into the broader health service sector.

From a developmental perspective, Professor Sun's practice in TCM industrialization has undergone three stages of evolution: exploration at the cultivation end in the 1990s (GAP base construction), mainly addressing "where medicinal materials come from"; productdevelopment at the product end in the first decade of the 21st century (herbal paste formulations, herbal beverages, and medicinaledeible products), primarily solving "how to make good use of good medicinal materials"; and since the 2010s, fullindustrychain integration (from cultivation to cultural tourism, from introduction of exotic species to localization, from single products to a broader health ecosystem), tackling "how to form a sustainable industrial ecology." These three stages are progressively interlinked and mutually reinforcing, constituting a complete industrialization methodology.

The core spirit of Professor Sun Xiaosheng's philosophy on TCM industrialization can be encapsulated as "upholding fundamental principles while pursuing innovation" (shouzheng chuangxin): upholding the fundamentals of TCM theory — consistently adhering to core TCM principles such as treatment based on

syndrome differentiation, homology of medicine and food, and individualized treatment according to person, time, and place; while innovating in modern industrial forms — actively introducing modern scientific and management approaches such as GAP standards, modern pharmacology, data mining, network pharmacology, and intelligent manufacturing, while also extending the TCM industry into new business forms such as wellness tourism and broader health services. This systematic pathway — “from the field to the clinic, from classics to products, from introduced species to localization, and from culture to industry” — offers a theoretical paradigm and practical model worthy of reference for the highquality development of the TCM industry. Looking ahead, the concepts championed by Professor Sun — “wholeindustrychain synergy,” “green and sustainable development,” “dualdriven by science & technology and culture,” and “equal emphasis on introduction and localization” — will continue to play a guiding role in the deepening implementation of the “Healthy China” strategy and the ongoing industrialization and internationalization of TCM.

Disclosure statement

The authors declare no conflict of interest.

References

- [1] Sun XS, Xie B, 2015, Research on Index System and Evaluation Model for Green Sustainable Development of Traditional Chinese Medicine Industry. China Press of Traditional Chinese Medicine, Beijing.
- [2] Sun XS, Xie B, 2008, Interface Management: A New Trend in Technology Innovation Management for Pharmaceutical Manufacturing Enterprises. China Pharmaceutical Technology Economics and Management, 2008(11): 52–57.
- [3] Xing Y, Sun XS, 2010, SWOT Analysis and Prospects of Undergraduate Education in Health Service Management. Contemporary Educational Forum (Management Research), 2010(7): 79–80.
- [4] Sun XS, Li Y, 2009, Thoughts on the Development of Humanities and Social Sciences Education in Chinese Medical Colleges. Medicine and Society, 22(4): 71–73.
- [5] Lin JW, Zhen QY, Sun XS, 2015, Analysis of Prescription Rules for Oral Formulas Treating Grey Hair Based on Traditional Chinese Medicine Inheritance Support System. Journal of Traditional Chinese Medicine, 56(23): 2006–2009.
- [6] Sun XS, Li L, 2012, Study on the Construction of Standards for Guangdong Traditional Chinese Medicine Culture and Health Tourism Demonstration Bases — A Case Analysis of Yanminghu Tourist Resort in Meizhou. Journal of Traditional Chinese Medicine Management, 20(8): 730–733.
- [7] Zhang J, Cao F, Lyu CJ, et al., 2020, Application Research of Traditional Chinese Medicine Culture in Health-oriented Characteristic Towns. Asia-Pacific Traditional Medicine, 16(5): 14–16.
- [8] Lin JW, Chen J, Huang QZ, et al., 2016, Data Mining Analysis of Prescription Rules for Infertility Formulas. Chinese Journal of Experimental Traditional Medical Formulae, 22(4): 218–221.
- [9] Hu ZR, Wu DH, Zhang YT, et al., 2019, Literature Research and Data Mining on Cough Based on the Complete Collection of Ancient and Modern Books · Medical Department. Lishizhen Medicine and Materia Medica Research, 30(11): 2775–2777.
- [10] Li L, Sun XS, 2016, Research on the Development of Traditional Chinese Medicine Health Tourism in Guangdong Based on Tourist Satisfaction. China Market, 2016(21): 229–231.

- [11] Sun XS, Li L, 2013, Research on the Current Situation and Countermeasures of Traditional Chinese Medicine Culture and Health Tourism Development in Guangdong. *Journal of Traditional Chinese Medicine Management*, 21(5): 442–444.
- [12] Wang P, Liu Y, 2024, A Preliminary Discussion on the Development Strategy of “Medicine and Food Homology” Industry from the Perspective of Traditional Chinese Medicine. *China Brand and Anti-Counterfeiting*, 2024(S1): 17–18.
- [13] Chen Y, 2014, Medical Literature Analysis of *Poria cocos* and Quality Research from Different Origins, thesis, Guangzhou University of Chinese Medicine.
- [14] Wang HF, 2020, Study on the Anti-pathogenic Microorganism Activity of Aromatic Essential Oil from Introduced *Melaleuca alternifolia*, thesis, Guangzhou University of Chinese Medicine.
- [15] Wang K, Liu SS, Guo QY, et al., 2016, Protective Effect of Maca Powder on Ovaries in a Rat Model of Premature Ovarian Failure with Kidney-yang Deficiency. *China Pharmacy*, 27(28): 3929–3932.
- [16] Ou JW, 2017, Clinical and Experimental Study of Curcumin Combined with Vitamin C in Triple-negative Breast Cancer, thesis, Guangzhou University of Chinese Medicine.
- [17] Lai MX, Liao LP, Lin JW, et al., 2019, Experimental Study on Catalpol Regulating Hedgehog Signaling Pathway to Promote Osteogenic Differentiation of BMSCs. *Immunological Journal*, 35(11): 921–926 + 933.
- [18] Li L, Zhang T, 2024, Inheritance and Innovation of the Whole Traditional Chinese Medicine Industry Chain Empowered by Modern Technology. *Chinese Traditional Patent Medicine*, 46(10): 3540–3544.
- [19] Tan WL, Wu ZJ, Zhang DP, et al., 2018, Regulatory Effects of Fuzi Lizhong Decoction on Immune Indicators Including NALP-3 Inflammasome in Colonic Mucosa of Rats with Diarrhea-Predominant Irritable Bowel Syndrome. *Journal of Chinese Medicinal Materials*, 41(4): 970–974.
- [20] Yi YH, Lyu JL, Liu SN, et al., 2015, Extraction, Purification and Antioxidant Activity of Total Flavonoids from the Leaves of *Ipomoea cairica*. *China Food Additives*, 2015(5): 86–92.
- [21] Liu Y, Yang BY, Xu ZP, et al., 2016, Flavonoid Chemical Constituents from the Fruits of *Nicandra physaloides* and their Immunomodulatory Activities. *Chinese Traditional and Herbal Drugs*, 47(22): 3965–3969.
- [22] Sun XS, 2011, On the Research Elements and Spatiotemporal Dimensions of Lingnan Medicine. *Journal of Guangzhou University of Traditional Chinese Medicine*, 28(6): 648–650.
- [23] Zheng H, 2009, Lingnan Medicine and Culture. Guangdong Science and Technology Press, Guangzhou, 243–245.
- [24] Wu MY, Tang XM, Xie B, et al., 2018, Anti-inflammatory Pharmacodynamics of Yanwo Sangju Yin Granules. *Guiding Journal of Traditional Chinese Medicine and Pharmacy*, 24(2): 53–55.
- [25] Sun XS, 2011, Six Major Characteristics of Mingyi Bielu and its Application in Dietary Therapy and Health Preservation. *New Chinese Medicine*, 43(3): 118–119.
- [26] Xu ZW, Wu HM, Liu XB, 2015, Summary of the Characteristics of Lingnan Medicine. *Chinese Journal of Basic Medicine in Traditional Chinese Medicine*, 21(9): 1083–1084.
- [27] Mi FF, 2015, Research on the Development of Traditional Chinese Medicine Culture and Health Tourism in Huizhou, thesis, Guangzhou University of Chinese Medicine.
- [28] Zhang J, 2019, Research on the Development of Forest Health Tourism in Guangdong Province, thesis, Guangzhou University of Chinese Medicine.

Publisher's note

Bio-Byword Scientific Publishing remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.