



Cross-border Collaborative Development Potential of Agricultural Resources between Yunfu (China) and Macao: A Case Study of Yunfu's Health and Medicine Industry

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Abstract. This study explores collaboration pathways in the health and medicine industry between Yunfu City, Guangdong Province, China, and the Macao Special Administrative Region. Analysis reveals Yunfu's abundant medicinal resources (204 families, 684 genera, 1,152 species; 88,867 hectares cultivated) and complete industrial chain, complemented by Macao's international advantages and research capabilities, exemplified by dedicated TCM research centers. The paper proposes four collaboration pathways: policy coordination, industrial chain collaboration, technological innovation, and brand marketing, with specific implementation steps including a joint conference system and a TCM Industry Cooperation Park. While this collaboration has the potential to significantly advance TCM's internationalization and contribute to global health solutions, challenges such as aligning quality standards, enhancing brand recognition, and addressing talent shortages persist. The study concludes that deepening cooperation can leverage respective advantages, achieve mutual benefits, and promote TCM's global role, but requires joint efforts to overcome existing challenges and continuously advance collaboration.

Keywords: Health and Medicine Industry Cooperation; Guangdong-Macao Cooperation; Industrial Chain Integration; International Development; Traditional Chinese Medicine

1 Introduction

In the context of globalization and increasing health demands, Traditional Chinese Medicine (TCM) is becoming an integral part of the global health industry. This study focuses on the potential collaboration in the TCM industry between Yunfu City, western Guangdong Province, and the Macao Special Administrative Region. Located 200 kilometers west of Guangzhou, Yunfu (7,779 km², population 2.5 million) features a

subtropical monsoon climate and rich biodiversity, making it a crucial southern medicinal herb production area. Macao, 300 kilometers south of Yunfu on the Pearl River estuary's western side, leverages its international background as a former Portuguese colony (returned to China in 1999) to facilitate TCM internationalization.

The Yunfu-Macao cooperation aims to promote both regional economic development and TCM's global expansion. Based on Yunfu's current TCM industry status, this study analyzes collaboration advantages and challenges, exploring potential cooperation pathways within China's Greater Bay Area. Key challenges include aligning quality standards, enhancing Yunfu's herb brand recognition, and addressing multidisciplinary talent shortages. By leveraging regional strengths and addressing these challenges, this collaboration could create a model for cross-border TCM industry cooperation, advancing its inheritance, innovation, and internationalization.

1.1 Theoretical Framework

This study employs Michael Porter's Diamond Model [1] to analyze the competitive advantages in Yunfu-Macao TCM industry cooperation. Through this model's four key factors: In factor conditions, Yunfu contributes rich medicinal resources (1,152 species across 88,867 hectares) while Macao offers international connections; for demand conditions, growing global TCM demand combines with Macao's international market access, supported by Yunfu's robust local industry (9.426 billion yuan output in 2023); in related and supporting industries, Yunfu's 92 manufacturing enterprises and 16 industrialization bases complement Macao's research institutions; regarding firm strategy, structure, and rivalry, the complementary advantages foster innovation and efficiency through healthy competition and cooperation. This theoretical framework guides the analysis of their TCM industry cooperation potential and strategies.

2 Research Background

2.1 Current Status of Yunfu's TCM Industry

Yunfu City is a significant southern medicinal herb production area in Guangdong Province, endowed with abundant medicinal plant resources. According to statistics, Yunfu City hosts medicinal plant resources from 204 families, 684 genera, and 1,152 species, accounting for 8.9% of the total medicinal plants in China (12,935 species) and 44.31% of those in Guangdong Province (2,600 species). Among these, there are 670 common medicinal plant species, including *Cinnamomum cassia*, *Myrica rubra*, and *Murraya exotica*. Yunfu City also boasts 32 rare plant species, including 5 national first-class protected plants (such as *Alsophila spinulosa*, *Ginkgo biloba*, *Glyptostrobus pensilis*, *Dendrobium officinale*, and *Dendrobium thyrsiflorum*) and 27 national second-class protected plants [3].

In terms of industry scale, as of June 2024, the cumulative planting area of southern medicinal herbs in the city reached 1.333 million mu (approximately 88,867 hectares). The city primarily cultivates and produces 58 varieties, representing 21.71% of

the total cultivated varieties in China (280 species) and 58% of those in Guangdong (100 species). The main varieties include *Cinnamomum cassia*, *Morinda officinalis*, *Morus alba*, *Illicium verum*, and *Heterosmilax japonica*, among others. In 2023, the city's total production of southern medicinal herbs reached 398,400 tons, with the entire industry achieving a total output value of 9.426 billion yuan[4].

As shown in Table 1, *Cinnamomum cassia* dominates the planting area, accounting for nearly 70% of the total, while other species like *Morinda officinalis*, *Morus alba*, *Heterosmilax japonica*, and *Illicium verum* each occupy smaller but significant portions of the planting area.

In terms of processing and manufacturing, the city has 92 TCM (southern medicinal herb) related manufacturing enterprises, including 30 above-designated-size enterprises. In 2023, the total industrial output value of above-designated-size enterprises reached 3.413 billion yuan, and in the first half of 2024, it reached 1.783 billion yuan. In terms of trade and circulation, in 2023, the city had 13 above-designated-size TCM trading enterprises, with sales reaching 1.016 billion yuan.

Table 1. Distribution of Southern Medicinal Herb Planting Area in Yunfu City.

Species	Percentage
<i>Cinnamomum cassia</i>	69.39%
<i>Morinda officinalis</i>	3.57%
<i>Morus alba</i>	3.30%
<i>Heterosmilax japonica</i>	3.00%
<i>Illicium verum</i>	2.63%
Others	18.11%

Regarding standardized cultivation, Yunfu City has established 132 standardized southern medicinal herb plantation demonstration bases, covering a total planting area of approximately 148,000 mu (about 9,867 hectares). This includes 16 Guangdong Province TCM industrialization bases and 15 seed and seedling breeding bases, with an annual production capacity of about 100 million high-quality seedlings.

These data fully demonstrate the scale and potential of Yunfu City's TCM industry, laying a solid foundation for cooperation with Macao.

2.2 Advantages of Macao's TCM Industry Development

The Macao Special Administrative Region possesses unique advantages in developing the TCM industry. Firstly, Macao enjoys a significant geographical advantage as an important window connecting the mainland with international markets, facilitating the entry of TCM products into the global market.

Secondly, the Macao SAR government highly values the development of the TCM industry and has likely implemented a series of supportive policies, creating a favorable policy environment for industry development [2]. In terms of scientific research, Macao's higher education institutions have likely invested substantial resources in TCM research, establishing relevant research platforms and demonstrating considerable research capabilities.

Furthermore, Macao has a healthcare system and legal framework aligned with international standards, an advantage that benefits the internationalization of TCM. Lastly, Macao likely possesses multidisciplinary talents proficient in both Chinese and Western medicine and familiar with international regulations, providing human resource support for innovation and internationalization in the TCM industry.

A comparison of TCM Industry Advantages between Yunfu and Macao is presented in Table 2. This comparison highlights the complementary nature of the two regions' strengths in the TCM industry.

Table 2. Comparison of TCM Industry Advantages between Yunfu and Macao.

Yunfu	Macao
Rich medicinal resources	International advantages
Complete industrial chain	Research capabilities
Advanced cultivation techniques	Policy support
Processing capabilities	Talent advantages

As shown in Table 2, while Yunfu excels in medicinal resources, industrial chain completeness, cultivation techniques, and processing capabilities, Macao brings complementary strengths in international connections, research prowess, supportive policies, and talent pool. This complementarity forms a strong basis for potential collaboration between the two regions.

While we lack specific data on Macao's TCM industry, these advantages undoubtedly create favorable conditions for cooperation between Yunfu and Macao in the TCM industry. The synergy between Yunfu's robust production capabilities and Macao's international outlook could potentially drive significant advancements in the TCM sector.

3 Advantages and Challenges of Yunfu-Macao TCM Industry Cooperation

3.1 Cooperation Advantages

The cooperation between Yunfu and Macao in the TCM industry presents significant advantages. Firstly, the two regions have highly complementary resources. Yunfu possesses abundant medicinal herb resources and a complete industrial chain [5], while Macao offers international advantages and research capabilities. This complementarity creates conditions for in-depth cooperation.

Secondly, Yunfu has already formed a relatively complete TCM industry system. The city has established 132 standardized southern medicinal herb plantation demonstration bases, covering a total planting area of approximately 148,000 mu (about 9,867 hectares). Meanwhile, Yunfu has 92 TCM (southern medicinal herb) related manufacturing enterprises, including 30 above-designated-size enterprises, laying a solid industrial foundation for deepening cooperation.

Moreover, Yunfu has unique advantages in under-forest southern medicinal herb cultivation. Leveraging Yunfu's ecological resource endowment, the city currently has

300,000 mu (about 20,000 hectares) of utilizable forestland with slopes less than 25 degrees and 1.6 million mu (about 106,667 hectares) of utilizable dry slopes and orchards, providing ample space for developing under-forest southern medicinal herb cultivation. Currently, Yunfu has 3 provincial-level under-forest economy (southern medicinal herb) demonstration bases and 2 Guangdong Province industrialization bases (in under-forest planting), covering a total area of 16,520 mu (about 1,101 hectares).

3.2 Challenges Faced

However, the cooperation also faces numerous challenges. Firstly, the lack of a systematic and regular cooperation mechanism may affect the depth and sustainability of collaboration. Secondly, there may be differences between Yunfu and Macao in TCM quality standards and production norms, requiring coordination and unification. Moreover, while Yunfu's southern medicinal herbs are resource-rich, their brand recognition and influence still need improvement. Additionally, the internationalization level of Yunfu's TCM industry is not high, placing it at a disadvantage in international market competition. Finally, there is a shortage of high-level, multidisciplinary talents, especially those familiar with international regulations and proficient in TCM, which may constrain the industry's innovation and internationalization process.

4 Advantages and Challenges of Yunfu-Macao TCM Industry Cooperation

4.1 Strengthen Policy Coordination and Construct Cooperation Framework

Firstly, policy coordination should be strengthened to construct a cooperation framework. A Yunfu-Macao TCM Industry Cooperation Joint Conference System could be established, with regular meetings to coordinate and resolve major issues in cooperation. Simultaneously, a joint Yunfu-Macao TCM Industry Cooperation Development Plan should be formulated, clarifying cooperation objectives, key areas, and specific measures.

Furthermore, efforts should be made to accelerate the mutual recognition of TCM quality standards and production norms between the two regions, and to establish a fast-track green channel for TCM products, creating conditions for product circulation.

4.2 Construct a Comprehensive Industrial Chain Cooperation Model

Secondly, a comprehensive industrial chain cooperation model should be constructed. Yunfu's land resources and cultivation techniques can be utilized to cooperate with Macao enterprises in building medicinal herb plantation bases that meet international standards. Particular emphasis should be placed on fully utilizing Yunfu's existing 300,000 mu of utilizable forestland and 1.6 million mu of utilizable dry slopes and

orchards to vigorously develop under-forest southern medicinal herb cultivation, creating a distinctive under-forest economy industrial chain.

Simultaneously, leveraging Yunfu's raw material advantages and Macao's research capabilities, joint efforts should be made to develop high value-added TCM deep-processing products. Currently, Yunfu has 59 southern medicinal herb deep-processing enterprises, accounting for 60.82% of the city's TCM (southern medicinal herb) related manufacturing enterprises, but there is still considerable room for development. Focus should be placed on developing categories such as pharmaceutical production (Chinese patent medicines, Western medicines), prepared Chinese medicine slices, Chinese veterinary medicine manufacturing, health food production, and daily cosmetics manufacturing to enhance product added value.

A "Yunfu-Macao TCM Industry Cooperation Park" should be established in Yunfu, attracting Macao TCM enterprises to settle and form an industrial cluster. The experience of Yunfu's existing 16 Guangdong Province TCM industrialization bases can be leveraged to create a high-level TCM industrial park. A Yunfu TCM product logistics and distribution center should be set up in Macao to facilitate product entry into the international market.

4.3 Promote Technological Innovation to Enhance Industrial Competitiveness

Finally, a brand marketing system should be created to expand into international markets. A "Yunfu-Macao TCM" regional public brand could be created to enhance product recognition and reputation. A Yunfu TCM product exhibition and trading center should be established in Macao as a window for products to enter the international market.

Utilizing Macao's international advantages, joint participation in international exhibitions and cross-border e-commerce cooperation should be conducted to expand overseas markets. Combining Yunfu's medicinal herb plantation bases with Macao's tourism resources, TCM cultural tourism routes should be developed to enhance brand influence.

5 Conclusion and Outlook

The Yunfu-Macao TCM industry cooperation presents tremendous potential for mutual development and innovation. Through strategic policy coordination, establishment of a comprehensive industrial chain cooperation model, advancement of technological innovation, and development of sophisticated brand marketing systems, the distinctive advantages of both regions can be effectively leveraged to achieve substantial mutual benefits[6]. As the Guangdong-Hong Kong-Macao Greater Bay Area continues to evolve, this cooperation is expected to deepen significantly, potentially emerging as a pioneering model for TCM internationalization. Nevertheless, significant challenges persist in enhancing cooperation mechanisms, harmonizing standard systems, and elevating brand influence in global markets. Addressing these challenges necessitates coordinated efforts from governments, enterprises, and research institu-

tions across both regions. Furthermore, paramount attention must be directed toward sustainable development practices, carefully balancing industrial growth with ecological conservation and resource sustainability.

In conclusion, the strategic deepening of Yunfu-Macao TCM industry cooperation promises not only to catalyze regional economic development but also to significantly advance TCM's global competitiveness. Building on our comprehensive analysis, we propose several critical directions for future research: 1. Digital TCM Innovation: Investigating the integration of advanced technologies such as blockchain and AI for enhanced product traceability and quality assurance throughout the supply chain; 2. Intellectual Property Protection Framework: Examining and developing robust international cooperation mechanisms for safeguarding TCM-related intellectual property, with particular emphasis on traditional knowledge preservation and genetic resource protection; 3. Climate Change Adaptation: Analyzing the comprehensive impacts of climate variations on medicinal herb cultivation and supply chain resilience, with specific focus on developing adaptive strategies for the Yunfu region; 4. Global Consumer Behavior Analysis: Conducting in-depth studies of TCM product acceptance and perception in international markets, particularly in regions where Macao maintains strong commercial and cultural connections; 5. Policy Harmonization Initiatives: Exploring sophisticated strategies for aligning TCM-related policies and regulations among Mainland China, Macao, and key international markets to facilitate seamless cross-border cooperation and trade; 6. Sustainable Development Integration: Investigating how the Yunfu-Macao TCM cooperation can substantively contribute to the United Nations Sustainable Development Goals, specifically in areas of public health enhancement, sustainable economic growth, and environmental conservation. These strategic research directions will not only deepen our understanding of regional cooperation dynamics but also significantly contribute to the broader advancement of international TCM development and cross-border industry collaboration.

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