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A STUDY ON THE SUPPLY CHAIN OF YUNNAN'S TRADITIONAL CHINESE MEDICINAL MATERIALS FROM THE PERSPECTIVE OF THE SCENT ECONOMY

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ABSTRACT

To address the developmental dilemma of Yunnan's traditional Chinese medicinal materials—characterized by “abundant resources but a small-scale industry”—this paper draws on supply chain management theory and employs a four-dimensional analytical framework of “upstream—midstream—downstream—collaboration” to systematically examine the constraints faced at each stage in the transformation of Yunnan's traditional Chinese medicinal materials into the fragrance industry. The study found that weak scientific research support for fragrance quality, the absence of harvesting standards, insufficient deep processing capabilities, limited influence of end-market brands, and the lack of a traceability system tailored to the fragrance industry collectively hinder the efficient transformation of Yunnan's TCM resources into high-value-added fragrance products. It is recommended to strengthen scientific research support and standardization for fragrance quality, enhance deep processing capabilities across the entire fragrance industry chain, cultivate end-market demand drivers in the fragrance sector, and establish a full-chain traceability system covering “fragrance fingerprints.”

KEYWORDS: olfactory economy, Chinese medicinal materials, supply chain, Yunnan

1. INTRODUCTION

According to the latest “2026 China Perfume Industry Research and Consumer Insights Report” released by iiMedia Research, the size of China's perfume market reached 25 billion yuan in 2024 and is projected to grow to 51.5 billion yuan by 2029. Within the fragrance industry chain, the integration of traditional Chinese medicinal materials into fragrance products has already gained significant momentum. Baoding, Hebei Province, has leveraged Anguo's advantages in the cultivation and distribution of traditional Chinese medicinal materials to develop an industry for producing incense from these materials, and has now established a complete industrial chain ^[1]. This indicates that by integrating into the incense industry chain, the economic value of traditional Chinese medicinal materials is expected to be further unlocked.

Yunnan is the province with the richest resources of traditional Chinese medicinal materials in China. Results from the Fourth National Survey of Traditional Chinese Medicinal Resources show that China currently has 18,817 species of traditional Chinese medicinal materials, of which Yunnan possesses 8,875 species—nearly half of the national total ^[2]. In the first three quarters of 2025, the province's TCM herb cultivation area reached 12.148 million mu, with a yield of 730,000 metric tons ^[3]; Yunnan has identified or introduced nearly 400 species of aromatic plants across 36 families and 179 genera, ranking first nationally in the number of species and accounting for over 55% of the total ^[4].

However, the industry faces significant shortcomings. The growth rate of the province's TCM herb processing output value was only 0.92%, far below the growth rate of production ^[3]; the scale of the aromatic plant processing industry remains relatively small, with its output value accounting for only 6%–8% of the national total, and the industry as a whole remains at the primary processing stage ^[4]. Although 15 types of TCM herbs in the province have completed registration as new cosmetic ingredients ^[5], the province's abundant resource advantages have not been fully translated into market and industrial competitiveness. There is a significant disconnect between resource reserves and industrial economic benefits. The core issue lies in the lack of supporting infrastructure across the entire supply chain, making it difficult to drive the value upgrade of Chinese medicinal materials from basic medicinal raw materials to deeply processed raw materials for the fragrance industry.

This paper adopts a four-dimensional supply chain analysis framework of “upstream–midstream–downstream–synergy” ^[6] to analyze the supply chain constraints in the transformation of Yunnan's Chinese medicinal materials into the fragrance industry and proposes optimization pathways.

2. THEORETICAL FOUNDATION

Supply chain management theory holds that any complete industrial process—from raw materials to end products—is composed of multiple interconnected links, with each link being interdependent and mutually constraining. A bottleneck in any single link will propagate along the chain, thereby affecting the realization of end-product value. When analyzing the value dilemma of end products, one cannot examine a single link in isolation; rather, one must adopt a full-chain perspective and systematically examine each link to fully uncover the root causes of the problem. Based on this theoretical logic, this paper incorporates core stages—including cultivation, processing, branding, and traceability—involved in the transformation of Yunnan's traditional Chinese medicinal materials into the fragrance industry into a unified analytical framework. By systematically examining the constraints present in each stage and identifying key bottlenecks along the industrial chain, this paper lays the analytical foundation for proposing optimization strategies.

3. Supply Chain Constraints on the Transformation of Yunnan's Traditional Chinese Medicinal Herbs into the Fragrance Industry

3.1 Cultivation Stage: Lack of Research Support Focused on Aromatic Quality and Harvesting Standards

The primary factor in transforming traditional Chinese medicinal herbs into fragrances lies in whether the cultivation stage can provide raw materials with “controllable aromatic quality.” However, the current cultivation of traditional Chinese medicinal herbs in Yunnan is driven by medicinal demand, with variety selection and breeding prioritizing yield and active ingredient content, while paying insufficient attention to the targeted cultivation of aromatic compounds. Varieties receiving funding from science and technology programs are primarily concentrated on major species such as *Panax notoginseng* and *Andrographis paniculata*, while research on other authentic Yunnan medicinal herbs, such as cardamom, remains limited ^[5].

This medicinal orientation is also reflected in the harvesting process. Current harvesting standards for Chinese medicinal herbs use medicinal components as the core indicator; harvesting is permitted once the content of active ingredients meets specified requirements, rather than aiming to optimize aromatic quality. Taking cardamom as an example, relevant studies conducted essential oil analyses on samples collected at seven different harvest times, identifying a total of 54 aromatic compounds. Among these, the relative content of eucalyptol—a key aromatic component in the essential oil ^[7] used in the formulation of flavorings and fragrances ^[8]—reached as high as 25.25% and 25.22% in cardamom harvested in December and January, respectively, whereas that of cardamom harvested in July was only 0.42% ^[8]. This indicates that the harvest period has a decisive impact on the aromatic quality of cardamom, and harvest standards focused on medicinal efficacy cannot ensure optimal aromatic quality. However, the current cultivation practices have not incorporated “aromatic quality” into the harvest standard system, and there is a lack of systematic recording and control of aromatic components, thereby limiting cardamom’s potential for transformation into a high-end fragrance ingredient.

3.2 Processing Stage: Weak Capacity for Value-Added Processing

The key transformation from “medicinal materials” to “fragrance ingredients” occurs during the processing stage. Yunnan’s natural fragrance industry exhibits a typical pattern of “strong raw material supply but weak processing capacity.” Value-added products account for a low proportion of total output, and a large volume of raw materials is exported in their primary form, resulting in a significant loss of value added for the industry. Take a certain resource development company in Yunnan as an example. As one of the leading enterprises in the province’s natural fragrance industry with strong chemical processing capabilities, the company is committed to developing local fragrance products such as essential oils, green cosmetics, and green food additives. However, fragrance raw materials still account for about 60% of its export products ^[4], indicating that its capacity for deep processing remains limited. The Kunming International Supply Chain Demonstration Center of Yunnan

Construction Investment Logistics is Yunnan's first smart industrial park integrating five major functions: deep processing, cold-chain warehousing, smart management, scientific and technological innovation and R&D, and exhibition and experience. However, its production capacity is primarily concentrated on food-grade products ^[9], and its deep processing capabilities for fragrance-grade raw materials (such as essential oils, purified oils, and extracts) remain relatively weak. Consequently, the shortcomings in Yunnan's natural fragrance industry regarding deep processing capabilities are constraining the extension of the value chain for traditional Chinese medicinal materials from primary raw materials to high-value-added fragrance products.

3.3 Branding: Insufficient Brand Impact at the End-User Level

Although Yunnan is home to some of the strongest companies in China's natural fragrance industry, their business focus is primarily on the raw material supply chain; they have not yet developed perfume or fragrance brands with strong market recognition for the end-consumer market. This issue is not unique to the fragrance industry. In their study of the supply chain for Yunnan's plateau-specific agricultural products, Liu Changbo et al. pointed out that the region's supply chain "lacks integration and lacks a chain-leading enterprise, particularly a leading enterprise in both production and sales" ^[10]. As an important component of plateau-specific agricultural products, traditional Chinese medicinal materials face the same structural challenge. Without quality standards set by end-consumer brands to guide upstream cultivation and processing, the value of fragrance cannot be effectively channeled back into the industry through brand premiums. The gap is particularly evident when compared to the Baoding, Hebei model. Baoding did not stop at raw materials or primary processing; instead, incense manufacturers directly transformed Chinese herbal medicines into end-consumer fragrance products, establishing the "Baoding Incense" regional brand in the consumer market. Qingyuan District has already attracted more than 500 upstream and downstream enterprises, employing over 50,000 people ^[1]. Yunnan also possesses Chinese herbal medicine resources and a foundation for the incense manufacturing industry; however, due to the lack of a brand portfolio targeting the consumer market, the aromatic value of Chinese herbal medicines has consistently failed to generate value through end-consumer brand premiums.

3.4 Traceability: A traceability system tailored to the fragrance industry has not yet been established

Fragrance brands need to convey a narrative of "natural ingredient sourcing" to consumers, which requires the supply chain to provide traceable and verifiable ingredient information. Although Yunnan's traditional Chinese medicinal materials traceability system has achieved "end-to-end traceability" and "comprehensive traceability," its development objectives and functional positioning are oriented toward medicinal needs, focusing primarily on ensuring the "safety" and "medicinal efficacy" of the materials. no dedicated traceability platform has been established for the production

of incense from Chinese medicinal herbs or the processing of fragrance raw materials, nor have fragrance quality indicators—such as “volatile compound profiles”—been incorporated into the scope of traceability. The lack of fragrance quality information means that during the transformation of Chinese medicinal herbs from “medicinal raw materials” to “fragrance raw materials,” downstream supply chain participants cannot access verifiable fragrance quality data, thereby weakening the traceability system’s ability to serve the fragrance industry.

4. PATHWAYS FOR OPTIMIZING THE SUPPLY CHAIN FOR THE TRANSITION OF YUNNAN’S TRADITIONAL CHINESE MEDICINAL HERBS TO THE FRAGRANCE INDUSTRY

4.1 Cultivation Stage: Strengthening Scientific Research Support and Standard Development for Aromatic Quality

Focusing on research investment and harvesting standards, efforts will be made to align Yunnan’s medicinal herbs with the raw material requirements of the fragrance industry. First, establish a dedicated research program for authentic medicinal herbs with aromatic properties, prioritizing species such as cardamom, amomum, and turmeric—which possess prominent aromatic characteristics and significant potential for application in the fragrance industry—and conduct systematic research on the formation mechanisms of their characteristic aromatic compounds and the targeted cultivation of aromatic quality. Second, develop variety-specific harvesting technical specifications with aromatic quality as the core guiding principle. The characteristic aromatic compounds of different aromatic medicinal materials vary significantly in type and composition. It is necessary to conduct in-depth analyses of the dynamic accumulation patterns of these compounds throughout the growth cycle for each variety and, based on changes in the content of their characteristic aromatic compounds, determine the optimal harvesting period for each variety to meet the needs of fragrance processing. Taking cardamom as an example, the content of its core characteristic aromatic compound, eucalyptol, peaks between December and January of the following year^[8], which allows for the clear identification of the optimal harvest period for cardamom to meet the requirements of the fragrance industry. Other aromatic medicinal plant varieties can follow the research approach outlined above to establish corresponding harvesting standards based on the accumulation patterns of their specific aromatic compounds. This will address the shortcomings of current Chinese medicinal plant cultivation standards regarding aromatic quality and ensure that medicinal plant raw materials of optimal aromatic quality are supplied to the fragrance processing sector from the very source of cultivation.

4.2 Processing Stage: Building Advanced Processing Capabilities for the Fragrance Industry

Focusing on three dimensions—industry orientation, production capacity structure, and on-site processing—we will strive to enhance the processing and conversion capabilities for fragrance raw materials. First, we will clarify the raw material needs of the fragrance industry. Building on the 15

new cosmetic raw materials already registered in Yunnan ^[5], priority will be given to species with prominent aromatic properties—such as cardamom, amomum, and turmeric—to develop raw material categories required by the fragrance industry, including essential oils, purified oils, and extracts. This will gradually establish specialized production lines for the fragrance, cosmetics, and personal care sectors, transforming the current production capacity structure, which is primarily focused on food-grade primary processing. Second, determine processing methods based on the characteristic aromatic components of target species. Aromatic components of different species vary in stability and extraction difficulty; processing methods should be selected and optimized accordingly. Third, move processing operations closer to the source. Expand the coverage of species processed while fresh ^[5], completing the transformation from fresh medicinal materials to fragrance-grade raw materials at the source to minimize quality loss during long-distance transportation and provide downstream fragrance brands with a raw material foundation that can be directly used for end-product development.

4.3 Branding Phase: Cultivating End-User Demand in the Fragrance Sector

Building on the existing corporate foundation, the focus will shift from product manufacturing to brand development. Drawing on Baoding's successful model for cultivating local fragrance brands—which centers on large-scale industrial parks as core spatial platforms and is underpinned by distinctive cultural experiences and core technological R&D innovation^[1]—this initiative will closely leverage the unique ecological endowments of the “Yunxiang” highland origin and the distinctive characteristics of its medicinal plant resources. By coordinating efforts across multiple pathways—including promoting the spatial clustering of the industry, strengthening the empowerment of Yunnan's regional and ethnic cultural values, and solidifying the R&D support for core extraction and fragrance formulation technologies—we will gradually cultivate a portfolio of local fragrance brands with clear market recognition and differentiated product competitiveness. This will enable the unique natural aromatic value inherent in Yunnan's traditional Chinese medicinal materials to achieve an industrial leap from raw material value to brand value through systematic brand management.

4.4 Traceability Phase: Establishing a Full-Chain Traceability System Covering “Fragrance Fingerprints”

Establish a fragrance quality traceability system tailored to the fragrance industry. In terms of implementation, one approach is to add a fragrance information module to the existing “Digital Cloud Medicine” platform, or to build a separate, independent traceability platform specifically for the fragrance industry. The key lies in achieving full-chain traceability of fragrance quality data from cultivation and processing through to distribution. Research by Yang Mingli et al. shows that odor recognition methods based on electronic nose systems can achieve an accuracy rate of up to 95% in identifying the fragrance quality of agricultural products ^[11]. Drawing on this technical approach, odor detection equipment can be introduced during the processing stage to convert the “aroma fingerprint”

of Chinese medicinal materials into quantifiable, traceable data indicators. At the same time, drawing on the principles of blockchain-based traceability^[12], aroma quality data from each stage can be stored on the blockchain to ensure that aroma information is tamper-proof and fully traceable throughout the entire process, thereby providing the fragrance industry with verifiable data on the aroma quality of raw materials.

5. CONCLUSION

From a supply chain perspective, this paper explores the constraints and optimization pathways for the transformation of Yunnan's traditional Chinese medicinal materials into the fragrance industry. The study found that the expansion of Yunnan's traditional Chinese medicinal materials into the fragrance sector faces four major obstacles: a lack of aroma-quality-oriented scientific research support and harvesting standards in the cultivation stage; weak capabilities in deep processing; insufficient end-market brand development; and the absence of a traceability system tailored to the fragrance industry.

To address these issues, this paper proposes four optimization pathways: in the cultivation phase, prioritize scientific research investment and harvesting standards to better align Yunnan's medicinal herbs with the raw material requirements of the fragrance industry; in the processing phase, focus on three dimensions—industry orientation, production capacity structure, and on-site processing—to enhance the processing and conversion capabilities for fragrance raw materials; in the branding phase, leverage the existing corporate foundation to drive a transition from product manufacturing to brand building; in the traceability phase, a fragrance quality traceability system tailored to the fragrance industry will be established. These four pathways mutually reinforce one another, collectively promoting the extension of the Chinese herbal medicine supply chain from a “medicinal orientation” to a “fragrance orientation,” thereby providing a supply-chain-level roadmap for the transformation of Yunnan's Chinese herbal medicines into the fragrance industry.

The limitations of this paper include: the discussion of differences in aromatic components among various types of aromatic medicinal herbs and their corresponding cultivation and processing requirements remains insufficient; furthermore, it fails to analyze the suitability conditions of the supply chain for specific varieties of Chinese medicinal herbs on a case-by-case basis. Future research could focus on specific varieties to thoroughly investigate the patterns of aromatic component accumulation and the coordination mechanisms among various links in the supply chain, thereby providing more precise theoretical support for the transformation of Yunnan's Chinese medicinal herb industry toward the fragrance sector.

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