



From Periphery to Nexus: Decoding Borderland Agency in Reshaping Transnational Fragrance Value Chains - Empirical Evidence from Yunnan's Plant-Based Aroma Industry

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Abstract: This article explores the fragrance and flavour industry from a global perspective, particularly focusing on the cooperation and development in Yunnan and the Lancang-Mekong region (Myanmar, Laos, Thailand, Cambodia, Vietnam). Yunnan, as the main production area for natural spices in China, boasts rich spice resources and policy advantages, yet it remains at the lower end of the global industry chain. The countries in the Lancang-Mekong region occupy a significant position in the global spice supply chain due to their unique geographical and climatic conditions. Through comparative analysis methods, combined with theories of regionalism, competitive advantage, and international competitiveness, this article examines the competitiveness of the fragrance and flavour industry in the Lancang-Mekong region, and proposes development suggestions such as strengthening regional cooperation, enhancing technological innovation capabilities, and building brands. The research indicates that through the Lancang-Mekong cooperation mechanism, resource sharing, technological exchange, and brand internationalisation can be promoted, thereby driving the green and sustainable development of the regional spice industry.

Keywords: Borderland Agency, Transnational Fragrance Value Chains, Plant-Based Aroma Industry, Yunnan Province, Periphery-Nexus Transition

Research Background

Spice plants refer to those that can yield essential oils, volatile oils, or components containing spices and non-volatile resins from certain parts of the plant. This includes aromatic plants that can be used for both medicinal and culinary purposes, as well as a small number of semi-shrubs and shrubs ^[1]. Spices are substances that possess fragrance, while flavourings are mixtures containing two or more, even dozens, of spices, artificially blended to create a specific aroma. Spices are divided into two main categories: natural spices and synthetic spices. Natural spices are derived from plants, animals, or microorganisms, processed through physical methods, enzymatic methods, microbial methods, or traditional food processing techniques. Synthetic spices, also known as artificially synthesised spices, are created by imitating natural spices using different raw materials through chemical or biological synthesis, resulting in a specific single entity spice ^[2]. The variety of spice plants on Earth is vast; currently, around 500 types of natural spices are effectively utilised, while there are over 6,000 synthetic spices, with more than 100 commonly used spices ^[3].

The history of the development of spice plants can be traced back 5,000 years, with ancient civilisations such as China, India, Egypt, and Greece being among the first to utilise spice plants. In the early days, they were primarily used for bathing, healing, worship, sacrifices, flavouring, and preservation. The *Bencao gangmu* (Compendium of Materia Medica) written by Li Shizhen during the Ming Dynasty (1368 – 1644) already separated spice plants into a distinct section titled *Fangxiang* chapter, systematically detailing the sources, processing, and applications of various spices ^[4]. Currently, various types of spice plants are widely distributed across the northwest, north, northeast, southwest, south, and east-central regions of China. Depending on the climate, the representative spice plants in each region also vary. The following figure shows the distribution of natural flavour plant resources in China.

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Figure 1: Distribution of natural flavour plant resources in China

From traditional Arab merchants transporting spices from the East to Europe across the desert to the modern successful introduction of spices into non-native countries where they were not native species, the trading methods and markets of this industry have undergone significant changes [5]. With the deepening of globalisation, spice trade is no longer confined to the traditional Eastern markets but has expanded globally. Particularly, the Lancang-Mekong region, including China's Yunnan Province and neighbouring countries or regions such as Myanmar, Laos, Thailand, Cambodia, and Vietnam, has become an important link in the global spice supply chain

due to their unique geographical and climatic conditions. In recent years, the pursuit of a natural, green, and healthy lifestyle has made medicinal spice plants increasingly popular among the public [6].

Currently, the global international spice market is thriving with bright prospects, and its market scale is growing at an average annual rate far exceeding the global average economic growth levels. According to statistics, in 2022, the global flavour and fragrance market reached 196.4 billion RMB, with an output value of 250.7 billion RMB, compared to only 17.2 billion RMB in 2015. The market share of the fragrance and flavour industry varies in different regions of the world. Data from 2021 shows that the United States accounts for 32% of the total share, Europe 22%, Asia the largest at 40%, and Africa and the Middle East only 6%. The following figure shows the regional distribution of global flavors and fragrances market share in 2021.

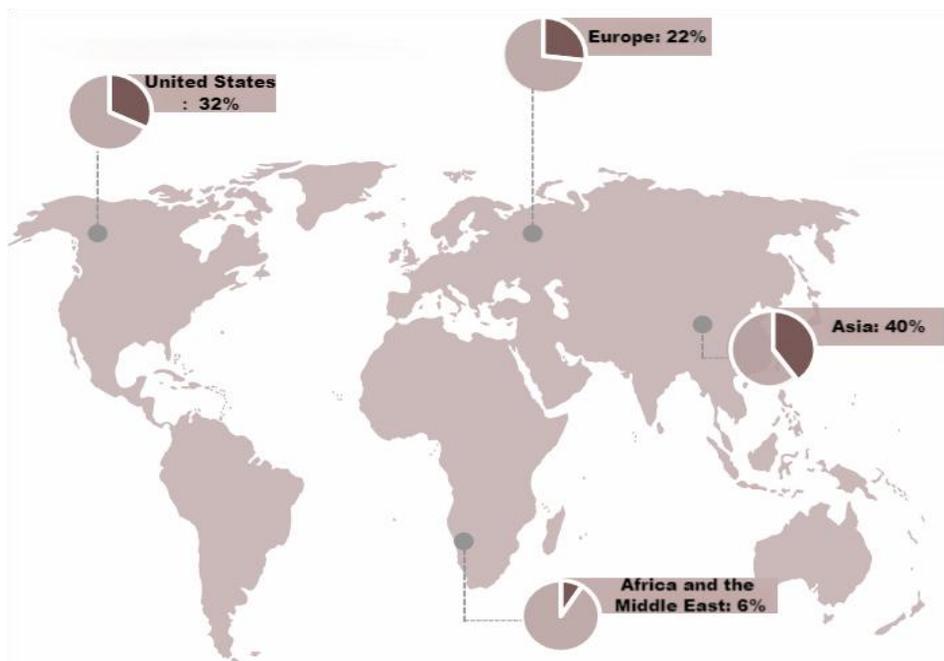


Figure 2: Global Flavour & Fragrance Market Share Distribution by Region, 2021

As a significant location for the global fragrance and flavour market, China's fragrance and flavour industry has also seen rapid development in recent years. In 2022, there were over 224,000 related enterprises in China, producing approximately one-third of their flavour and fragrance products for export, with spice products accounting for about two-thirds. The export volumes of vanillin, linalool, and maltol each accounted for roughly 50% of global supply. The flavour and fragrance market in China reached 56 billion RMB, representing 28.5%

of the global market, with its output value accounting for nearly one-third of the world's total. The latest report from iiMedia Research, titled *2024-2025 Global and China Spice and Flavour Industry Operation Big Data and Investment Value Analysis Report* indicates that the market size of China's spice and flavour industry is expected to exceed 50 billion RMB by 2026 [7].

Due to the increasing demand of high-quality and diverse spices at the globe, the spice industry faces dual pressures of quality and supply. The rise of organic spices and convenience foods has also brought new development opportunities and challenges to the spice industry. In this context, strengthening cooperation and development within the region is particularly important. This article aims to explore the current international competitiveness of the fragrance and spice industry in the Lancang-Mekong region, as well as the cooperation and development of the fragrance and spice industry,

through comparative analysis methods. This research not only helps in understanding the distribution of resources and market demand within the region but also promotes cooperation among countries in the region regarding spice production and trade, thereby enhancing the overall competitiveness of the region in the global spice market.

Theoretical Foundations

Firstly, the theory of regionalism posits that neighbouring countries or regions possess certain complementarities and common interests in economic, political, and cultural aspects. By strengthening regional cooperation, it is possible to optimize resource allocation, enhance economic efficiency, and boost regional competitiveness^[8]. The international river Lancang-Mekong connects six countries, forming the Greater Mekong Subregion (GMS), which includes China's Yunnan Province, as well as Myanmar, Laos, Thailand, Cambodia, and Vietnam. This area is the cradle of civilisations in Southeast Asian countries and a channel for exchange, covering a total area of 2.5688 million km², with a regional population of approximately 320 million people. There are over 90 ethnic groups and more than 100 ethnic branches, with 16 ethnic groups being cross-border communities with China. This region is vast, resource-rich, and densely populated. It is an area of confluence for aromatic plants grown in China's southwestern region and its neighbouring countries, which facilitates to form a distinct regional culture. In addition, this region also witnesses the confluence of different processing technologies for fragrances and spices^[9]. In a political and social context that is still fledgling, Lancang-Mekong countries can prioritise the development of economic cooperation. Through deepening economic collaboration, trust and interdependence among Lancang-Mekong countries can gradually be established, which would contribute to increase trade benefits, reduce transaction costs, and mitigate economic uncertainties and risks. Eventually, those efforts would lay a solid foundation for future cooperation among stakeholders in Lancang-Mekong region. Therefore, for better enhancing regional economic integration, the Lancang-Mekong countries should align with global development initiatives to accelerate cooperation in the fragrance and spice industry. As a key part of the Belt and Road Initiative, Yunnan needs to fully leverage its geographical advantages to promote the construction of international transport corridors with neighbouring countries, creating a new fertile grounds for economic cooperation in the Greater Mekong Subregion and establishing itself as a hub oriented outwards in the direction of South Asia and Southeast Asia. By strengthening cooperation with Lancang-Mekong countries, Yunnan can also better utilise its geographical advantage to promote the development of the spice industry.

Secondly, the theory of absolute advantage that was first articulated by Adam Smith in his classic work *The Wealth of Nations* in 1776. This theory remarkably reveals the significant differences in production efficiency and costs amongst countries due to variations among them in terms of production technology, thereby facilitating the natural formation of international industrial division of labour. Smith emphasizes that the cornerstone of international trade lies in the absolute advantages existed between countries—where a particular country (or region) demonstrates higher efficiency in the production of specific goods compared to others (absolute advantage), while possibly exhibiting lower efficiency in the production of other goods (absolute disadvantage)^[10]. Applying this theory to the fragrance and flavour industry, it argues that for the Lancang-Mekong region to effectively enhance its competitiveness in the international fragrance and flavour market, it is imperative for the stakeholders of this region to ambitiously promoting the research and development of processing and manufacturing technologies.

In the early 19th century, David Ricardo first elucidated the principle of comparative advantage in his work *Principles of Political Economy and Taxation*. He pointed out that even if a country (or region) is at a relative disadvantage in the production of all goods compared to another country (or region), mutually beneficial trade can still be achieved. The critical point advocate in Ricardo's work is that countries (or regions) should focus on producing and exporting products where their absolute disadvantages are relatively small (i.e., where they have a greater relative advantage), while importing those products where they have significant absolute disadvantages^[11]. If this principle is applied to the fragrance and flavour industry, the Lancang-Mekong region exhibits unique potential and prospects for cooperation. Every country in the Lancang-Mekong region possesses its own unique comparative advantage in terms of quality, yield, or distinctive flavours. Through the Lancang-Mekong cooperation platform as a bridge, countries can fully leverage their edge over others to promote fragrance and flavour products with comparative advantages to the international market, which eventually leads to achieve specialised production and scaled exports.

Thirdly, the international competitiveness theory is introduced in the analysis of this research, which prioritizes three areas of concern. The first point is to generate profits and increase the market share^[12]. The second concern is maintaining the share of a country's products in the global market over a long period. The third point is maintain high productivity and its acceptance across markets^[13]. Since international competitiveness is influenced by comparative advantage and competitive advantage, the factors affecting the international competitiveness of agricultural products can be divided into internal and external factors. Internal factors are the main components of comparative advantage, including labour, capital, and resource endowments, etc. External factors are the main components of competitive advantage, consisting of five aspects. The first aspect is technological innovation driven by market demand. Effectively addressing the issue of product adaptation to market needs, technological innovation leads to new varieties, new breeding methods, and new production management procedures based on new market standards, thereby improving production efficiency and expanding the consumer market. Secondly, it is of significance to promote industrial structure reform and select the best competitive model in order to adjust the industrial structure. The third point is establishing efficient marketing channels that adapt to

market demand. The fourth point is policy support and public assistance. Government tax, quarantine, and related support policies, along with public funding, are important factors for the development of agricultural production export enterprises. The fifth point is brand reputation and corporate image. With economic development and increasing consumer income, consumption goals have shifted from mass products to distinctive, high-quality branded products, with a significant profit gap between the two. For example, farmers sell fresh fruit to buyers for about 3 RMB or 4 RMB per kilogram. After drying, the price rises to 30 RMB or 40 RMB per kilogram. Through the marketing and selling by merchants, it can even reach 200 RMB per kilogram ^[14].

The International Competitiveness Analysis Of The Yunnan Flavour And Fragrance Industry

Firstly, in terms of the resource endowment, China is rich in natural aromatic plant resources, with over 400 species of aromatic plants, including unique varieties such as cinnamon and star anise. Yunnan is the main production area for natural fragrances in China, boasting the largest variety and a wide range of aromatic crops in the country ^[15]. According to literature, Yunnan has over 900 species of aromatic plants, accounting for 80% to 90% of the China's aromatic plant varieties. Moreover, 90% of the world's aromatic plants can grow outdoors in Yunnan. Of the nearly 30,000 species of higher plants in the country, Yunnan accounts for over 60%. The region has a staggering 6,559 types of medicinal materials and 6,157 species of medicinal plants, representing 51.4% and 55.4% of the national totals, respectively. In addition, Yunnan leads the national the number of fragrance and flavour varieties, ranks fourth in total production, and contributes 15% of the national export volume, providing a solid foundation in terms of raw material supply for the development of the fragrance and flavour industry ^[16].

Secondly, in terms of the industrial structure, the Chinese fragrance and flavour industry primarily focuses on the production of synthetic fragrances and flavours, while Yunnan's flavour industry is distinguished by its natural fragrances and flavours. The development of the *Yunxiang* industry began in the 1950s, initially adopting a development strategy centred on the large-scale introduction of new varieties. In 1959, a fragrance factory was established in Kunming, Yunnan, followed by the establishment of flavour cultivation bases in Dehong Dai and Jingpo Autonomous Prefecture, Yuxi City, and Pu'er City. After 60 years of development, Yunnan Province's flavour industry has reached a certain scale. Currently, there are over 30 enterprises engaged in flavour production and processing, with cultivation bases covering 133,333 hectares, and around 400,000 farming households are involved in planting and initial processing, which covers approximately 2 million people ^[17]. Yunnan has discovered and introduced nearly 400 types of natural flavour crops, with the production and export volumes accounting for nearly 30% of the national total. Products are exported to over 20 countries and regions, including India, Germany, and the Netherlands. Among these, eucalyptus oil accounts for over 90% of global trade, while the production of two natural fragrances, bay leaf oil, and lemongrass oil, also comprises over 30% of the global market share. The international luxury brand Hermès has even named a high-end perfume as Hermès Hermessence Osmanthe Yunnan ^[18]. In 2024, the export value data for major fragrance and flavour products from Yunnan in the first quarter was quite good. The export value of other plant juices and extracts was 0.19 million USD, oxalic acid had an export value of 0.1 million USD, eucalyptus oil reached an export value of 0.155 million USD, and unspecified non-citrus fruit essential oils had an export value of 6.255 million USD. Additionally, the export value of other industrial mixed fragrances and mixtures with fragrances as basic components to Laos reached 0.09 million USD, while the export value of oxalic acid to Myanmar was 1 million USD. The following table summarizes the export value of major flavour and fragrance products in Yunnan, Jan-Mar Q1 2024:

Product Name	Exports	Export Area	Unit
Other Plant Juice and Paste	0.19	-	Billions of dollars
Oxalic acid	0.10	-	Billions of dollars
Eucalyptus oil	0.155	-	Billions of dollars
Essential oils of non-citrus fruits	6.255	-	Millions of dollars
Spice blends and mixtures of spices as basic ingredients for other industrial uses	0.09	Laos	Ten million dollars
Oxalic acid	1	Myanmar	Ten million dollars
Other Plant Juice and Paste	0.19	-	Billions of dollars
Oxalic acid	0.10	-	Billions of dollars
Eucalyptus oil	0.155	-	Billions of dollars

Table 1: Export Value of Major Flavour and Fragrance Products in Yunnan, Jan-Mar (Q1) 2024

Thirdly, the flavour and fragrance industry in Yunnan province is effectively supported by the favorable policy. The Yunnan provincial government places great importance on the development of the natural fragrance industry, considering it one of the key industries with a solid industrial foundation and developmental advantages, the authorities have accelerated the establishment of China's largest fragrance production base ^[19]. Furthermore, Yunnan Province supports the development of the flavour and fragrance industry through the formulation and implementation of a series of policy measures, such as *the Outline of the 14th Five-Year Plan for National Economic and Social Development of Yunnan Province and the Long-term Goals for 2035*. In terms of public support, Yunnan not only provides policy backing but also adopts various pragmatic measures to promote the development of the flavour and fragrance industry. For example,

Yunnan utilises the Internet Plus model to drive the construction and development of fragrance industry clusters, actively exploring new development models. The following table summarizes the current policies or activities related to fragrances and flavours in yunnan.

Relevant Policies	Date Issued	Issuing Authority	Main content
Yunnan Provincial Government's Notice on Issuing the '14th Five-Year' High-Quality Development of Manufacturing Industry	May 2022	Yunnan Provincial Government	The plan mentions the promotion of industries such as fragrances and flavours, actively expanding and extending into daily use, food, and medicinal fields.
Yunnan Province '14th Five-Year' Pharmaceutical Industry Development Plan	March 2022	Yunnan Provincial Government	The plan focuses on the pharmaceutical industry, aiming to promote innovation and high-quality development in Yunnan's pharmaceutical sector
Yunnan Province Three-Year Action Plan for Strong Industry (2022—2024)	July 2022	General Office of the CPC Yunnan Provincial Committee	Aims to strengthen the scale of the real economy, promote the optimisation and upgrading of the industrial structure, enhance the quality, efficiency, and competitiveness of industrial development, and accelerate the construction of a strong industrial province.
Yunnan Provincial National Economic and Social Development 14th Five-Year Plan and Vision Goals for 2035	February 2021	Yunnan Provincial Government	Proposes the 14th Five-Year Plan for national economic and social development in Yunnan and the vision goals for 2035, aiming to promote high-quality leapfrog development of Yunnan's economy and society
Yunnan Spice Research and Development Centre	July 2012	Yunnan Spice Research and Development Centre	The centre was merged into Yunnan Agricultural University, becoming the Spice Research Institute of Yunnan Agricultural University, conducting research on the cultivation of spice plants, pest and disease control, and essential oil processing.
New Major in Fragrance and Essence Technology and Engineering	March 2022	Yunnan Economic Management College	Yunnan Economic Management College has been approved to add a new programme in Fragrance and Flavour Technology and Engineering, aiming to cultivate specialised talents in fragrance and flavour technology engineering to meet industry development needs.

Table 2: Current Policies or Activities Related to Fragrances and Flavours in Yunnan

Fourthly, in terms of the brand building, China's fragrance and flavour industry has been actively involved in brand development and market promotion. For instance, the China Fragrance and Flavour Cosmetic Industry Association has formulated *the 14th Five-Year Plan for the Development of the Fragrance and Flavour Industry*, striving to promote high-quality development through approaches such as technological advancement, cluster development, and green development^[20]. Although Yunnan's natural fragrance industry has a certain foundation and a set of advantages, there are still shortcomings in brand development and market promotion. The recognition of Yunnan's fragrance industry in both the domestic and international markets is relatively low, lacking strong brand support. This is mainly due to insufficient investment by Yunnan's fragrance companies in brand strategy, marketing, and product innovation. For example, Yunnan Hengrun Fragrance Company has been facing the challenges such as lack of diversity in products and ineffective innovation in its marketing strategy. In 2023, the top ten fragrance brands were mainly concentrated in Shanghai and Guangdong Province, while Yunnan faced challenges in the international market due to a lack of strong brand support, making it difficult to compete with international fragrance giants. These international giants typically possess greater market influence and their products enjoy considerable popularity, while Yunnan's fragrance processing companies often struggle due to the inefficiency in brand building and lack of international recognition. The following table summarizes the top ten brands of flavours and fragrances in 2023:

Rank	Brand Name	Company Name	Province/Address
1	HUABAO	Huabao Fragrance Co., Ltd.	Lhasa, Tibet
2	GIVAUDAN	Givaudan Flavours and Fragrances (Shanghai) Ltd.	Shanghai
3	FIRMENICH	Firmenich Flavours (China) Ltd.	Shanghai
4	IFF	International Flavours & Fragrances (China) Ltd.	Guangdong

5	SYMRISE	Symrise (Shanghai) Ltd.	Shanghai
6	APPLE	Apple Fragrance Group Co., Ltd.	Shanghai
7	BAIRUN	Shanghai Bairun Investment Holding Group Co., Ltd.	Shanghai
8	BOTON	Shenzhen Boton Fragrance Co., Ltd.	Guangdong
9	SENSIENT	Sensient Flavours and Colour Technology (China) Ltd.	Guangdong
10	HUAYE	Anhui Huaye Fragrance Co., Ltd.	Anhui

Table 3: Top 10 Brands of Flavours and Fragrances, 2023

In summary, Yunnan has developed a comprehensive advantage in raw material supply, but it is still in its early stages within the global industrial chain, with significant market potential and space for growth. The development of Yunnan's natural spice industry is also situated at the lowest end of the global spice industry chain, failing to transition from a low-end supply chain to a high-end one. The industry still primarily focuses on the processing of primary raw materials, with a relatively low market share for natural spices internationally [21]. Some spice processing products have not achieved mass industrial production and cannot substantially meet consumer demand for products. Many spice plant cultivation areas are dispersed and lack scale, making it difficult to adopt unified management, technical guidance, and scientific standards [22]. There is also a lack of unified leadership and organisational management, with a chaotic operating system and circulation management. Moreover, the lack of sector guidelines for regulating production further compounds the problem. These reasons mentioned above have led to blind expansion and production, market saturation, increased competition in the source market, resulting in price reductions and even product stagnation, which would actually lead to resource wastage [23].

Analysis Of The International Competitiveness Of The Fragrance And Flavour Industry In The Lancang-Mekong Region

The Asia-Pacific region holds a dominant position in the global fragrance and flavour market, accounting for a significant share of total revenue. This is due to a shift in consumer preferences towards nutritious and healthy food and beverages in populous countries such as China and India. Additionally, Asian flavours and aromas are increasingly popular in key regions of Europe and North America. Important markets for edible fragrances in the Asia-Pacific region include Vietnam, Indonesia, India, and China. The Lancang-Mekong countries play a crucial role in this context [24]. By analysing the international competitiveness of the fragrance and flavour industry in the five Lancang-Mekong countries, one can accurately identify the advantages and bottlenecks in developing the fragrance and flavour industry in the Lancang-Mekong region, thereby strengthening cooperation and development within the region.

1. Analysis of the International Competitiveness of Myanmar's Fragrance and Flavour Industry:

Myanmar is located in a region of the world historically renowned for its spices and seasonings, which add much enthusiasm and flavour to food. There is a Myanmar proverb, "Food is medicine, and medicine is food." [25]. Myanmar cuisine reflects the multicultural influences that have shaped the country's history. Its culinary offerings blend flavours from India, China, and Thailand. One of the hallmarks of Myanmar cuisine is its use of aromatic spices and herbs, which impart unique flavours and aromas to dishes. From turmeric to lemongrass, ginger, and coriander, Myanmar's spices and herbs are essential components of its gastronomy. For instance, turmeric is used in curries, soups, and stews, and is also added to rice and noodle dishes [26]. Lemongrass is a popular herb used in Myanmar cooking, valued for its citrus aroma and flavour, enhancing the taste of soups, curries, and stir-fries [27]. Myanmar boasts a total of 472 species of medicinal plants, with 13% assessed for conservation status and listed in the International Union for Conservation of Nature (IUCN) Red List [28] [29]. Additionally, Myanmar is home to many medicinal plants with potential therapeutic properties, including 15 species reviewed for phytochemical and pharmacological activity. For example, the *Taeniophyllum* genus, a type of orchid found in northern Myanmar, has a distinctive floral fragrance [30]. In Belonsat village in Myanmar, 11 species of spice plants are frequently used by locals, or were historically used by women as cosmetic care products, including basil (*Ocimum basilicum* L.), cardamom (*Amomum compactum* Sol. Ex Maton), turmeric (*Kaempferia galanga* L.), curcuma (*Curcuma heyneana* Val. & V), and ginger (*Zingiber officinale* var. *amarum*), elephant ginger (*Zingiber officinale* var. *officinatum*), among others. The parts used include leaves, rhizomes, fruits, seeds, and tubers, which are employed in body scrubs, facial masks, body deodorants, and nail strengtheners. The north-western state of Chin stands as one of the nation's least developed areas, where residents continue to harness natural treatments from its abundant biodiversity. Examples include *Alangium chinense*, *Anemone obtusiloba*, *Anneslea fragrans*, and *Antidesma bunioides*, which thrive extensively in Chin and possess considerable medicinal importance within the Ayurvedic healing tradition [31].

Myanmar possesses rich natural resources and diverse biodiversity, providing a unique source of raw materials for the fragrance and flavour industry. According to data from the International Fragrance Association (IFRA) [32], Myanmar is expected to become an important player in the global fragrance and flavour market between 2025 and 2030. In terms of investment prospects, with the increasing global demand for natural and sustainable products, Myanmar's fragrance and flavour industry is anticipated to experience significant growth. The government is promoting agricultural modernisation and export-oriented economic policies, which will further enhance the development of this sector [33]. Currently,

Myanmar's export competitiveness is primarily focused on primary products, including natural resources and the agricultural sector, but its competitiveness in the spice market is relatively weak [34]. Additionally, the technological lag and insufficient processing capacity within Myanmar's fragrance and flavour industry are major constraints on its development. The lack of industry standards and quality control systems also presents challenges regarding product quality that investors must contend with. Strengthened environmental protection regulations may increase production costs, and rising labour costs could also affect Myanmar's competitiveness in the global market [35].

2. Analysis of the International Competitiveness of Laos's Fragrance and Flavour Industry:

Laos is a country rich in herbal resources, with a diverse array of medicinal plants, including 57 species of ferns, 32 species of gymnosperms, and 2076 species of angiosperms [36]. The use of spices in Lao cuisine and culture is also quite unique, with commonly used spices including lemongrass, lime leaves, chilli, garlic, and turmeric powder. These spices not only enhance the flavour of food but also possess certain medicinal values [37]. Among them, Lao agarwood is one of the country's renowned spices, primarily sourced from the mountains bordering Laos and Vietnam, known for its distinctive and unique aroma, which has gained wide acceptance by modern consumers with its refreshing and pleasantly sweet cool taste. Additionally, Laos has a type of high-quality agarwood known as super agarwood, referred to in Lao as Mai Ka Ana, characterised by its rich resin content and crystalline appearance, with a glossy black colour. At room temperature, it emits a faint refreshing scent, and when burned, it initially produces a strong penetrating medicinal honey fragrance, followed by a subtle floral aroma [38]. Lao leopard tree camphor (*Meistera tomrey*) is also an important example; *Meistera tomrey* belongs to the ginger family and is native to the Indochina region, including Laos. Research has shown that the essential oil of *Meistera tomrey* contains various volatile compounds, which have potential applications in the fragrance and flavour industry [39]. The medicinal plant resources of Laos are not only widely used domestically but have also attracted international attention. On April 16, 2017, a signing ceremony for *the Memorandum of Understanding on Cooperation between the Chinese Medicine Resource Centre of the Chinese Academy of Traditional Chinese Medicine and the Traditional Chinese Medicine Research Institute of the Lao Ministry of Health* was held in Vientiane, the capital of Laos, where both parties agreed to jointly conduct research and development on special plant resources with economic medicinal value in Laos and to compile a *Flora of Laos* [40].

In Laos's fragrance and flavour industry, the perfume sector is a key focus. In 2022, Laos's exports of perfumes and cosmetics amounted to \$14.1 million, making it the 95th largest exporter of perfumes and cosmetics globally. In the same year, perfumes and cosmetics ranked 29th among Laos's export products. In 2022, Laos imported \$123 million worth of perfumes and cosmetics, becoming the 100th largest importer of these products worldwide. During the same year, perfumes and cosmetics ranked 13th among Laos's imported products [41]. In March 2022, HSMM Fragrance Co. Ltd., Laos' inaugural perfume label, debuted *Laos Lady* and *Black Rich* at the 2021 Outstanding Entrepreneur Made in Laos Awards held in Vientiane. Established in January 2021, the brand received a favourable reception and now boasts seven Eau de Parfums, with premium offerings *Dok Cham Pa* and *Sok Dee* among them. When this Laotian brand was launched, it faced its own challenges, uncertain about the market's reaction. Currently, the brand is set to open stores at Wattay International Airport in Vientiane and Luang Prabang Airport soon [42]. It is predicted that by 2024, the revenue of the Laotian perfume market will reach \$53.48 million, with this segment expected to grow at an annual rate of 2.76%. By 2024, Laos's per capita income will be \$6.91. By 2024, 69% of sales in the Laotian perfume market will come from non-luxury goods [43]. There has been a surge in demand for traditional herbal perfumes in Laos, reflecting a growing interest in scents with natural and cultural significance [44]. Currently, Laos's economy is primarily based on agriculture and it is heavily reliant on natural resources. The Herfindahl-Hirschman Index (HHI) for the Laotian fragrance and flavour market in 2023 is 8672, a slight decrease from 8907 in 2017, indicating that the market is moving towards a highly concentrated direction. The following figure shows the trends in the hhl index of the market for exporting perfumes and flavours from Laos.



Figure 3: Trends in the HHI Index of the Market for Exporting Perfumes and Flavours

3. Analysis of the International Competitiveness of Thailand's Fragrance and Flavour Industry:

Thailand boasts a diverse array of aromatic plants, serving various purposes from traditional cooking to modern perfumery and pharmaceuticals. This includes lemongrass, galangal, kaffir lime leaves, basil, mint, coriander, turmeric, coriander seeds, fennel seeds, garlic, and shallots [45]. Long-stemmed Litsea (Thummong, Litsea petiolata), native to southern Thailand, has highly aromatic leaves often used as a substitute for traditional water beetle (Lethocerus indicus) in Thai cuisine [46]. Plants from the Zanthoxylum genus are widely distributed in northern Thailand, including hairy pepper, bamboo leaf pepper, Thai pepper and multi-flower pepper [47]. These plants are used not only as spices but also in traditional medicine. Their main chemical constituents are limonene and linalool, which impart a subtle lemon fragrance [48]. The Thai essential oil and spice industry holds a significant position in the global market, renowned for its unique flavours and high quality. The industry encompasses the production of both natural and synthetic spices. Natural spices are popular for their complex flavours but their yields are not bountiful and hence relatively expensive; synthetic spices, on the other hand, have a wide range of raw material sources and diverse product types [49]. Thai spice products are increasingly favoured by domestic and international consumers seeking products with natural ingredients, primarily due to concerns over safety and ecological issues [50]. This trend is driving the fragrance industry towards sustainable extraction techniques for natural products [51].

Thailand's fragrance and flavour industry has a long history and cultural background, particularly holding a unique position in the production of traditional spices and scents. The small family-run factories in Thailand play an important role in the production and processing of fragrances. These factories are mainly concentrated in rural areas, such as Roi Et Province, and produce items including scented candles and incense sticks [52]. Additionally, the market for herbal cosmetics in Thailand is continually expanding. In terms of market demand and consumer acceptance, Thai consumers exhibit a high level of acceptance for herbal cosmetics. They express satisfaction with the physical characteristics of herbal cosmetics, such as texture, scent, penetration properties, and viscosity [53]. Furthermore, the image of herbal cosmetics is influenced by intangible factors (such as psychological effects, product origin, and culture) as well as tangible factors (such as user benefits and product promises). Moreover, the marketing strategies for Thai herbal cosmetics also play an important role that encompass products, pricing, promotion, and sales [54]. For example, Thai herbal cosmetics have adopted the strategies to attract market attention by enhancing product quality, developing new products, creating aesthetically pleasing packaging, and launching new products. The pricing strategy employs cash discounts to increase consumer purchasing motivation. The placement strategy primarily uses department stores as distribution channels, while the promotional strategy utilises integrated marketing communication to maintain brand image. However, despite the potential for growth in the Thai herbal cosmetics market, imported products are often more appealing in terms of technology and packaging design, which may impact the competitiveness of local brands.

4. Analysis of the International Competitiveness of Cambodia's Fragrance and Flavour Industry:

Cambodia is rich in medicinal plant resources. According to *The Compilation and Study of Common Medicinal Plant Resources in Cambodia*, there are 228 commonly used medicinal plants in Cambodia, primarily from the legume, oleander, and ginger families, which are mainly used to treat gastrointestinal diseases [55]. Additionally, *Discussion on Common Traditional Medicinal Plants in Cambodia* also mentions that traditional medicine holds an important position in the healthcare field, with these medicinal plants widely used in traditional medicine [56]. Approximately 1,200 plant species have been recorded in Cambodia for treating diseases, with over 500 species used in traditional medicinal formulations [57]. According to the World Health Organization, 40% to 50% of Cambodians choose to use traditional medicine in their daily lives; when faced with illness, 70% to 80% of Cambodians opt for traditional medicine for treatment. Traditional medicine plays a significant role in treating common diseases [58]. In terms of edible aromatic plants, there is a high demand for jasmine in Cambodia, particularly during Buddhist ceremonies and weddings [59]. Furthermore, Cambodia places importance on the development and utilisation of agarwood. Agarwood is a precious natural fragrance with high market demand but low production, facing the issue of resource depletion [60]. Yunnan, located in the tropical and subtropical regions, has a climate similar to that of Cambodia, thus sharing many common or similar medicinal plants with Cambodia [61]. Statistics show that 77 plant species in Cambodia are also distributed and utilised in Yunnan. Those plant species are used to treat the similar ailments in both regions, primarily gastrointestinal diseases [62]. Research indicates that the plants in Cambodia are potentially good ingredients of antibacterial agents, providing raw materials for the development of antibacterial drugs and anti-pathogenic microbial medicines [63]. Cambodia's fragrance and spice industry is particularly famous for pepper, especially Kampot pepper, which enjoys a prestigious reputation in the international market and is known as the King of Pepper. The pepper industry in Cambodia has seen significant development in recent years; pepper is not only an important economic crop for Cambodia but also one of the country's key export products. The main growing areas for Cambodian pepper include Kampot, Pursat, and Takeo provinces, with a total planting area reaching 6,935 hectares and an annual output of approximately 23,000 tonnes. This pepper is renowned globally for its unique flavour and high quality, exported to various countries and regions including China, Vietnam, Germany, South Korea, Japan, France, and the United States. In May 2023, the General Administration of Customs of China officially approved the export of Cambodian pepper to China, making it the first Cambodian seasoning to be permitted for export to China. In addition to pepper, Cambodia also possesses abundant tropical spice plants, which

provides great potential opportunities for the country’s fragrance and spice industry to expand into international markets, particularly the Chinese market [64].

Cambodia’s fragrance and flavour market is projected to generate revenue of USD 128.8 million in 2024, with an expected compound annual growth rate of 3.22% from 2024 to 2029 [65]. The fragrance and flavour industry in Cambodia is moving towards a highly concentrated direction, with the Herfindahl-Hirschman Index (HHI) at 6704 in 2023, falling down from 9627 in 2017. It indicates an increase in the number of competitors in the market [66]. In the domestic market, Cambodia’s perfume and fragrance products industry has seen rapid growth in recent years, with more local companies producing high-quality perfumes that cater to both domestic and international customers. The production of perfumes in Cambodia is primarily for domestic consumption, but there are also efforts to export to foreign markets. For example, Atelier des Parfums de la Nature uses natural ingredients grown in Cambodia, such as jasmine and ylang-ylang essential oils, to produce natural perfumes and export their products to countries like France, China, Japan, and South Korea. The Cambodia Spice Beverage Research Institute is also promoting the investigation and technological advancement of pepper resources, which may further propel the development of Cambodia’s fragrance and flavour industry. The industry benefits from the country’s rich cultural traditions and the growing tourism sector, leading to an increasing demand for unique spices. Additionally, with the rise of e-commerce, Cambodia’s fragrance and flavour e-commerce market is expected to reach USD 1.2 million by 2024, with a projected compound annual growth rate of 14.5% from 2024 to 2028 [67]. The following figure shows the Cambodia’s fragrance and flavour export market hhi index trends.

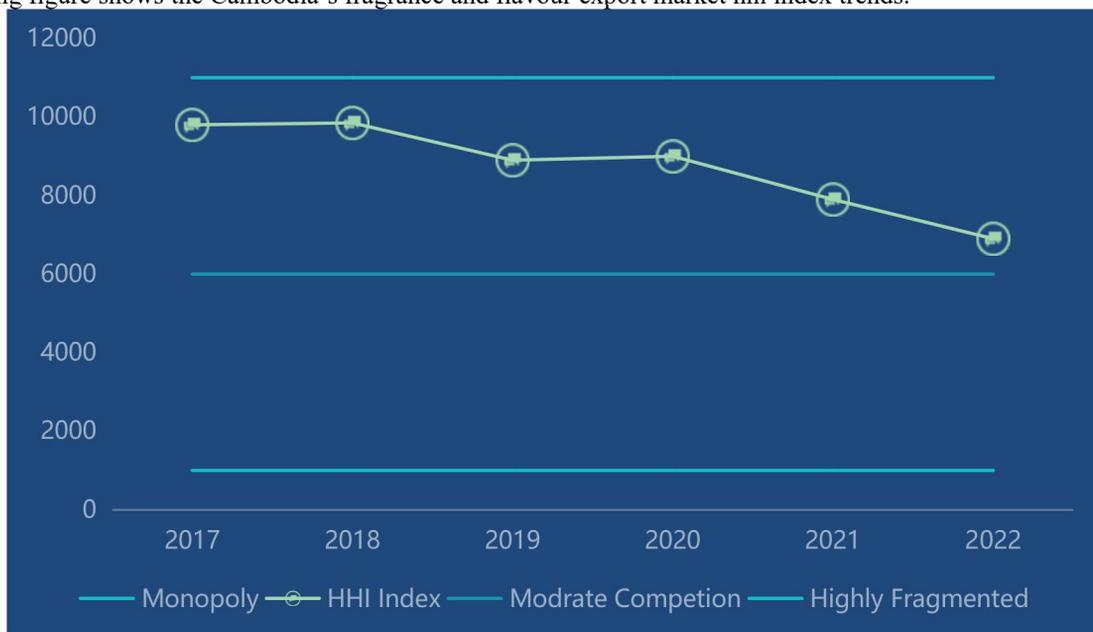


Figure 4: Cambodia’s Fragrance and Flavour Export Market HHI Index Trends

5. Analysis of the International Competitiveness of Vietnam’s Fragrance and Flavour Industry:

Vietnam boasts a rich array of plant resources, including a significant number of medicinal plants. According to a 2016 report, Vietnam has approximately 3,200 species of medicinal plants, of which one third are considered to have therapeutic effects [68]. In Vietnam, plants are commonly used through methods such as boiling, grinding, kneading, juicing, or brewing. In the Samadua district, the community utilises 54 types of plants to treat diabetes, hypertension, coughs, gout, cholesterol, diarrhoea, and other ailments [69]. Vietnam’s spice products are not only diverse but also highly regarded for their quality by customers around the globe. Vietnam ranks third on the world stage in spice supply and processing, primarily exporting products including pepper, cinnamon, star anise, chilli, nutmeg, ginger, and turmeric. The production and export volume of Vietnamese pepper is the highest in the world. Vietnam’s spice products demonstrate strong competitiveness in the global market, with exports to many overseas markets including the United States, the European Union, India, and China. According to the latest data from the Vietnam Pepper and Spice Association, in the first quarter of 2024, the country’s spice export volume came up to 87,400 tonnes, with a total value of \$322.7 million. Compared to the same period in 2023, the export volume declined by 24.1%, while the total export value decreased by 4.8%. Specifically, pepper, as the primary exported spice product, saw an export volume of 56,800 tonnes, accounting for 65% of the total export volume, with an export value of \$235.6 million. Although the export volume and value of pepper declined by 26% and 0.1% respectively, it remains the mainstay of exports. Cinnamon followed closely, with an export volume of 16,000 tonnes and an export value of \$46.2 million, but both experienced declines of 14.6% and 15.7% respectively. Other spices such as fennel, ginger, turmeric, cardamom, and nutmeg also faced bleak export prospects, with only chilli seeing an increase in export volume and value of 17.6% and 52.8% respectively. Furthermore, Vietnam has recently observed a downward trend in export values to India and China [70].

An Phuoc is the largest province in northern Vietnam for cinnamon cultivation in terms of both area under cultivation and the yield thereof, spanning across 86,000 hectares, the region boasts over 14,000 hectares of internationally certified organic cinnamon. Currently, 16 factories in the province specialise in cinnamon essential oil, producing a yearly total of 1,000 tonnes of related products. Additionally, there are over 400 small family-run cinnamon essential oil processing units, primarily operating manually, with an average annual output of 300 to 800 kilograms per unit. The province's cinnamon products have been exported to over 30 countries, such as South Korea, China, the United States, the United Kingdom and so on. At present, cinnamon production and processing in the province receive very little investment, still lacking development, characterized by low productivity and quality, and unable to satisfy the demands of both domestic and export markets. Regarding pepper products, according to statistics from the Binh Phuoc Department of Industry and Trade, in 2023, the province's pepper export value was also expected to decline significantly, reached merely US\$26 million, a 45% drop compared to the previous year's corresponding period. Currently, Binh Phuoc Nedspice stands as the sole exporter of spice products in the province. This firm manages factories producing 40,000 tonnes of products annually, comprising chilli, nutmeg, nutmeg shells, bell peppers, cassia, ginger, cloves, dill, and coriander, with chilli alone contributing 28,000 tonnes ^[71].

The Pathways For The Development Of The Fragrance And Flavour Industry In Yunnan Under The Lancang-Mekong Cooperation Mechanism

Through an analysis of the international competitiveness of the fragrance and flavour industry in the Lancang-Mekong region, it can be observed that the region possesses comparative advantages in terms of internal factors such as resource endowment, labour force, and capital. From the perspective of external factors affecting fragrance and flavour production, the industry in the Lancang-Mekong region enjoys sufficient policy support, such as facilitation in taxation, quarantine, and customs. However, two key issues require attention. Firstly, there is insufficient technological innovation capability in response to market demand across the countries. This shortcoming prevents effective solutions to adapt products to market needs, with a lack of new varieties, new farming methods, and new production management processes. Secondly, there is a deficiency in brand reputation management and corporate image building. The fragrance and flavour industry in the Lancang-Mekong region has yet to establish recognizable brands with international influence, and existing enterprises lack effective strategies and investment in brand promotion and marketing, leading to a lack of brand recognition and influence. As an province that actively participates in the Belt and Road Initiative, Yunnan urgently needs to methodically explore and efficiently utilise its unique geographical advantages, accelerate the construction of international logistics networks with neighbouring countries, and forge a new stage in economic cooperation in the Greater Mekong Subregion, thereby establishing itself as a thriving hub connecting South Asia and Southeast Asia.

On one hand, relying on the Lancang-Mekong cooperation mechanism, Yunnan should further strengthen collaboration in the research and development of essential oil processing technology. Currently, the Lancang-Mekong countries have developed a certain scale of aromatic industries in part because of their tropical climate and geographical conditions. However, in terms of processing technology, the overall approach remains relatively traditional, with varying degrees of application of modern processing technologies and equipment. Some countries still need to improve their scientific and technological-know how in areas such as essential oil extraction and refinement. For instance, in Vietnam, particularly in the Mekong Delta region, essential oils are still extracted from orange peels using steam distillation methods ^[72]. This technique has been applied in several experiments, such as in the cases of extracting essential oils from *Alphonsea tonquinensis* and other plants in Vietnam ^[73]. Existing research indicates that processing technologies such as membrane separation technology, molecular distillation technology, rotary cone column technology, and resin adsorption technology can enhance the quality of flavour and fragrance products, minimising the loss of flavour compounds during processing and usage, while also recovering valuable components, thereby increasing the market competitiveness and economic benefits of the products ^[74]. Furthermore, some spices were dehydrated using ultrasonic methods (such as bay leaves, onions, and mint) exhibit superior flavours compared to those dehydrated using air drying, infrared, microwave, and hot air drying methods. The fragrance of flavour compounds obtained through ultrasonic-assisted extraction are more intense resulting in a richer flavour profile in the extracts ^[75]. Therefore, it is essential to enhance the development of the spice industry between the Lancang-Mekong countries and China, especially Yunnan, through technical and experiential exchanges, promote technological innovation and product development, and encourage and support cooperation between enterprises and research institutions in areas such as spice variety improvement and production technology innovation. This will improve the research capabilities of deep processing of spices, develop a batch of high-tech, competitive, high value-added, and economically beneficial natural spice processing products, and upgrade the system of natural spice processing, facilitating the transformation of primary natural spice products towards deep processing, gradually advancing towards the high end of the value chain ^[76]. The following table summarizes the comparison of traditional natural plant spice extraction techniques and emerging technologies.

	Method	Advantages	Disadvantages
Natural Plant Spice Extraction Techniques	Steam Distillation Method	Simple operation, low cost, wide application range	Only suitable for raw materials whose aromatic components do not undergo significant changes due to

Emerging Technologies for Natural Plant Spices	Extraction Method	Better preservation of the plant's original aroma, mainly suitable for floral essential oils	steam heating High investment, high technical requirements
	Cold Pressing and Grinding Method	Suitable for citrus fruits and peels, complete retention of nutritional components	Relatively low oil yield, impure products
	Adsorption Method	High quality of product aroma, aromatic components are not easily destroyed	Adsorbents need regeneration, cannot operate continuously
	Molecular Distillation Method	High product yield, good quality, effectively removes heat-sensitive light molecular substances, clean production	High energy consumption, limited application areas
	Supercritical CO2 Extraction Technology	No chemical reactions, clean production, high safety, high oil yield and product quality	Limited applications, high investment costs
	Ultrasonic Extraction Method	Short extraction time, high yield, mild conditions	Careful parameter selection required

Table 4: Comparison of Traditional Natural Plant Spice Extraction Techniques and Emerging Technologies

Currently, Yunnan Xinyue Spice Technology Co., Ltd. is exploring research and development pathways. The company has formed a research and development team of 10 people, as well as a specialised research laboratory. The company has imported the most advanced scraping film distillation equipment and thin film molecular distillation equipment from abroad, and has developed approximately 20 new production processes and research achievements, with six patents granted. Its partners include the Kunming Institute of Botany of the Chinese Academy of Sciences, Yunnan Academy of Agricultural Sciences, Yunnan Spice Research and Development Centre, Yunnan University, Southwest Forestry University, the Third Military Medical University of the People's Liberation Army, and Guangdong Pharmaceutical University, among other research institutions. Following this model, the company aims to transform its resource advantages into economic advantages, with the potential for greater breakthroughs as it gradually moves towards the high end of the value chain. On this basis, Lancang-Mekong countries could also establish a multi-level cooperation mechanism by setting up dedicated working groups or forums to hold regular technical exchange meetings, promoting information sharing and technology transfer.

On the other hand, leveraging the Lancang-Mekong platform to create a highly recognized brand in the fragrance and flavour industry. Currently, the global fragrance and flavour market is primarily dominated by several strong brands, including Ajinomoto Co, Inc., Ariake Japan Co., SHS Group, Kerry Group plc, EVEREST Food Products Pvt. Ltd., Baria Pepper Co. Ltd., Associated British Foods plc, Kikkoman Corporation, among others. These major brands hold a significant share of the global fragrance and flavour market, originating from countries such as Japan, Ireland, India, Vietnam, the United Kingdom, and the United States ^[77].

Yunnan province is endowed with rich natural spice resources, providing exceptional conditions for the creation of distinctive spice brands. *The Yunnan Provincial National Economic and Social Development 14th Five-Year Plan and Vision Goals for 2035* also mentions the aim to establish a world-class green food brand ^[78]. For Yunnan to develop its unique spice brand, the Lancang-Mekong platform serves as an important facilitator. Under the backdrop of the Belt and Road Initiative, the Lancang-Mekong cooperation mechanism offers Yunnan a good platform for cultural exchange and economic cooperation with Southeast Asian countries or regions. By strengthening cooperation and exchanges with Lancang-Mekong countries and sharing brand experiences, not only can the market coverage of Yunnan's spice products be expanded, but the international recognition and competitiveness of its own brand can also be enhanced. Furthermore, such regional cooperation enables promotion of economic integration and cultural exchange within the region, bringing a positive impact on the economic development of Yunnan and the entire Lancang-Mekong area. For instance, joint initiatives akin to the Asia-Oceania Aroma Association (AOAA) could potentially be taken ^[79], such as sub-regional conferences, forums, or training sessions focusing on the spice and flavour industry in the Greater Mekong region, to facilitate exchanges, research, forums, technology, and trade cooperation among the spice and flavour industries of Lancang-Mekong countries. These activities could be initiated by the government, which would also participate in relevant coordination work, while academic institutions would be responsible for implementing specific tasks. With active support from the government and enthusiastic participation from research institutions and academic groups, the standard and academic level of the meetings could be significantly enhanced. Additionally, the exchange meetings could be held every two years in rotation among the regional countries, establishing a relatively stable platform for the exchange and cooperation of the spice and flavour industries in the region ^[80].

One of the Lancang-Mekong countries, Vietnam, has a domestic brand, Baria Pepper Co., Ltd., which is one of the world's top eight white pepper brands. The company specialises in the selection, trade, import, and export of various pepper products, with its products exported to the Americas, Europe, the Middle East, and other countries in Asia. It is understood that the key to the company's brand effect lies in standardizing the quality and price of Vietnamese pepper production, improving packaging information (such as product origin, content, photos, and contact details) to facilitate buyers' order placement, as well as engage with customers through online marketing^[81]. Currently, Kunming Hengrun Spices Co., Ltd. in Yunnan has demonstrated outstanding performance in building local competitive brands. Based on cooperation with world-class flavour and fragrance companies, the company has rapidly improved its standards in products, services, and management. In the future, Hengrun Spices plans to achieve sales of 600 million to 800 million RMB by 2026, aiming to establish a Chinese spice manufacturing brand in the international market and strengthen China's influence over pricing and its role in the global spice market.

Conclusion

This article comprehensively explores the cooperation and development of the fragrance and flavour industry in Yunnan and the Lancang-Mekong region, which includes Myanmar, Laos, Thailand, Cambodia, and Vietnam. Yunnan, as the main production area for natural spices in China, boasts abundant resources of spice plants, and its fragrance and flavour industry has shown a positive performance with strong policy support from the government. However, Yunnan still needs to strengthen its brand building and market promotion. Other countries in the Lancang-Mekong region also possess their own advantages and characteristics. For instance, Myanmar has rich resources of spice plants, Laos has an abundance of medicinal plant resources, Thailand's fragrance and flavour industry is renowned for its unique flavours and high quality, Cambodia has a well-developed pepper industry, and Vietnam is one of the world's major suppliers and processors of spices. The fragrance and flavour industry in the Lancang-Mekong region has comparative advantages in terms of resource endowments, labour, and capital, but there are shortcomings in technological innovation and brand building. To enhance the competitiveness of the entire region in the global spice market, it is essential to strengthen cooperation within the region in order to expand the share of the global market through joint efforts.

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