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A Study on the Current Development of Hainan's Green Food Flavor Industry and Its Strategic Countermeasures

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Abstract
Hainan Province, as one of the few regions in China free from heavy industrial pollution, enjoys unique geographic and climatic conditions that provide inherent advantages for the development of the green food industry. Green agricultural products not only contribute to high-quality regional economic growth but also play a crucial role in ensuring food safety and meeting the demands of consumption upgrading. Against the backdrop of Hainan's green food development strategy and the construction of the Hainan Free Trade Port, this study systematically reviews the current development status of Hainan's green food flavor industry and the major policy and institutional measures supporting its growth. It further examines the key challenges constraining the industry's sustainable development. Based on this analysis, the paper proposes a series of targeted countermeasures aimed at promoting high-quality industrial development and facilitating the transformation of Hainan's flavor industry from resource-based production to value-driven economic growth.

Keywords
green food; flavor industry; Hainan Province; Free Trade Port; high-quality development; whole industrial chain

1. Introduction

China has a long history of spice utilization and boasts a wide variety of aromatic plants. Spices have traditionally been used not only as culinary seasonings and aromatic vegetables in daily diets, but also for environmental fragrancing due to their distinctive aromas. Moreover, certain spices possess notable health-promoting properties derived from their unique chemical compositions, including aiding digestion, enhancing immune function, regulating blood glucose levels, lowering cholesterol, and exhibiting antibacterial effects [1]. Owing to its distinctive geographic location and climatic conditions, South China primarily produces resin-based spices, culinary seasonings, floral and herbal aromatics, as well as fruit-derived spices [2].

Located at the southernmost tip of China, Hainan Province benefits from abundant sunshine, plentiful rainfall, and a warm, humid tropical monsoon climate, creating highly favorable ecological conditions for aromatic plant cultivation. According to the Catalogue of Aromatic Plants in Hainan Island, the island is home

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to 329 aromatic plant species across 64 families and genera, including 191 wild species and 138 cultivated varieties. This exceptional biodiversity has earned Hainan the well-deserved reputation of being a "Kingdom of Spices."

The spice industry in Hainan has a long-standing history. Since the 1950s and 1960s, large-scale cultivation of lemongrass has been established, with lemongrass essential oil exported to international markets. However, for an extended period, Hainan's spice industry has remained trapped in the dilemma of "producing aroma without generating wealth," as its resource advantages have not been effectively translated into economic gains. Taking pepper as an example, in 2023 Hainan recorded a planting area of 19,016 hectares and an output of 37,216 tons, yet industrial profitability failed to increase proportionally.

In recent years, China's No. 1 Central Document has explicitly emphasized the expansion of green food and organic agricultural product supply, while green consumption concepts have gained widespread public acceptance. Meanwhile, the global spice market has maintained a compound annual growth rate exceeding 5%, creating significant development opportunities for Hainan's green food spice industry. In response, the Hainan provincial government has actively implemented supportive policies, providing a one-time subsidy of RMB 100,000 for each product certified as a national green food. The construction of the Hainan Free Trade Port has further strengthened these advantages through tariff reductions, tax incentives, and other policy dividends, injecting strong momentum into the development of the spice industry. As a key tourism-oriented province in China, Hainan prioritizes high-tech tourism and financial services, while industrial development remains relatively limited. This industrial structure has, in turn, preserved a pollution-free environment highly conducive to the cultivation of green food spices.

This study aims to conduct a case-based analysis of the current development status of Hainan's green food spice industry, accurately identify existing challenges, and propose scientifically grounded and feasible countermeasures to help the industry overcome development bottlenecks and achieve high-quality growth.

2. Current Development of Green Food and the Spice Industry in Hainan

2.1 Resource Endowments and Industrial Scale

Hainan is endowed with abundant natural cultivation resources and serves as an important national breeding base in China. The province is home to more than 337 species of plant- and animal-derived spices and has long been known as the "Fragrant Island," with a rich tradition of spice trade, appreciation, and cultural use. At present, Hainan has established large-scale spice cultivation bases, focusing primarily on agarwood, pandan leaves, chili peppers, lemongrass, and pepper. In addition, smaller-scale cultivation of specialty aromatic plants such as ylang-ylang and vanilla has been developed, providing a stable and sustainable raw material foundation for the continued growth of the spice industry.

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Table 1. Cultivation Area and Development of Major Spice Crops in Hainan Province in Recent Years

Spice Type	Cultivated Area (mu)	National / Global Status	Primary Uses
Pepper	330,000	Sixth largest production area worldwide; largest in China	Food seasoning; traditional Chinese medicine
Lemongrass	200,000	Historically dominant crop with long-standing advantages	Spice extraction; daily-use fragrance production
Agarwood	100,000	Over a millennium of cultivation history; premium quality	High-end perfume formulation; traditional Chinese medicine
Hainan Huanghuali (Rosewood)	90,000	Endemic and scarce resource	High-end furniture manufacturing; fragrance extraction
Pandan Leaf	5,000	Emerging advantageous crop	Food flavoring; culinary seasoning

2.2 Production Scale of Green Food Spices

Hainan Province has established a relatively comprehensive research and development system centered on the Hainan Green Food, Spice, and Beverage Research Institute (hereafter referred to as the "Spice & Beverage Institute"), which operates with core technical support from the Spice and Beverage Research Institute of the Chinese Academy of Tropical Agricultural Sciences. This system constitutes an integrated green food production framework combining scientific research, demonstration, and industrial application. The Institute has developed high-yield cultivation and pollution-free production demonstration bases covering approximately 200,000 square meters, focusing on key crops such as pepper, coffee, vanilla, cocoa, and kuding tea. Owing to its achievements, the Institute has been recognized as a "National Rural Science Popularization Demonstration Base" and a "Hainan Provincial Pollution-Free Agricultural Product Production Area," and several of its products have successfully obtained Geographical Indication (GI) certification.

Significant progress has also been made in new product development. To date, the Institute has successfully developed 32 science- and technology-based spice and beverage products, including vanilla series, coffee series, pepper series, and cocoa series, and has been granted 29 product patents. Among these innovations, the development of a purely natural herbal vanilla perfume has achieved phased success. Produced without any chemical additives and composed primarily of vanilla and alcohol, the perfume offers long-lasting fragrance and exhibits notable refreshing, detoxifying, and wind-dispelling effects traditionally associated with herbal products. In parallel, Hainan Province has actively advanced certification initiatives under the "Three Products and One Standard" framework. As of December 13, 2024, the province had 83 certified green food enterprises with 116 valid certified products, 6 certified organic agricultural enterprises with 14 certified organic products, 42 registered geographical indications for agricultural products, 18 newly recognized premium specialty agricultural products, and 12 green food supply-capacity products, collectively demonstrating a steady enhancement of industrial output and certification capacity.

2.3 Scientific Research Capacity and Innovation Outcomes

The Spice & Beverage Institute serves as the core scientific and technological backbone of Hainan's green food spice industry. Since as early as 1937, the Institute has conducted systematic experimental research on

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the introduction and cultivation of vanilla, gradually mastering its growth patterns, environmental adaptability, and field cultivation techniques. Through a six-year intensive research program involving thousands of experimental trials, Researcher Wang Qinghuang successfully achieved large-scale introduction and cultivation of vanilla in Hainan, reaching an annual dry pod yield of 3,515 kilograms per hectare—substantially exceeding the average yield of 1,650–2,228 kilograms per hectare in major global producing countries.

In terms of processing technology innovation, Dr. Gu Fenglin of the Institute developed a pepper peeling machine capable of fully mechanized, integrated processing of fresh pepper fruits, directly producing four categories of products: peppercorns, pepper powder, pepper juice, and pepper paste. This innovation effectively addressed longstanding challenges in pepper processing in Hainan and was awarded the First Prize of the Hainan Provincial Science and Technology Progress Award in 2017. Moreover, a collaborative effort between the Institute and a fragrance company based in Grasse, France, resulted in the launch of the limited-edition "Vanilla Perfume" commemorating the 60th anniversary of Xingke Company. This product was recognized with the "Hainan Provincial High-Tech Product Award," filling a gap in local perfume manufacturing and significantly enhancing the added value of vanilla products. Its market visibility and brand recognition within Hainan have since increased markedly.

International cooperation has also been extensive and substantive. Through platforms such as the "Joint Research Center for Tropical Spices and Beverages," the Institute has participated in cutting-edge research initiatives, including global coffee genomics projects. In addition, the Institute has actively promoted technology transfer abroad, exemplified by its technical support for a Myanmar demonstration project that replaced poppy cultivation with spice crops such as cardamom. This initiative not only improved local livelihoods but was also recognized as a "Best Poverty Reduction Case" in the Global Poverty Reduction Case Collection Campaign, contributing Chinese experience and expertise to global poverty alleviation efforts.

2.4 Policy Support and Development Environment

The development of the green food spice industry has received strong policy support from the Hainan Provincial Government, which has introduced a series of targeted incentive measures. The Notice on Several Fiscal Measures to Promote High-Quality Economic Development in Hainan Province (Qiongfu Ban [2021] No. 65) clearly stipulates one-time financial rewards for advanced manufacturing enterprises whose annual output value surpasses designated thresholds for the first time since 2021. It also provides policy support and financial incentives for green agricultural product processing enterprises, thereby optimizing the overall business environment.

Under the fiscal incentive policies implemented in 2021, enterprises obtaining green food certification were eligible for a one-time subsidy of RMB 100,000 per certified product, significantly boosting participation in certification programs. Of particular importance are the institutional advantages brought by the construction of the Hainan Free Trade Port. Under the processing value-added policy, industrial enterprises producing goods without imported components, or achieving a processing value-added rate of 30 percent or above, may transport products into the domestic market through the "second line" without paying import tariffs; only value-added tax and consumption tax are levied in accordance with regulations. This policy framework creates substantial cost advantages for the deep processing of spices in Hainan, effectively exempting import tariffs

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on the value-added portion generated during local processing and providing strong momentum for industrial upgrading.

3. Challenges Facing the Development of Hainan's Green Food and Spice Industry

3.1 Imbalanced Industrial Structure and Low Comprehensive Returns

Hainan's green food and spice industry exhibits a pronounced structural imbalance characterized by strong primary production but weak processing and marketing capacities. This imbalance has resulted in relatively low overall economic returns and has dampened farmers' enthusiasm for cultivation. Spice cultivation in Hainan requires substantial upfront investment, involves high labor intensity, and demands strict technical standards. After deducting production costs, profit margins are not significantly higher than those of winter vegetables such as melons and leafy crops, and in some cases are even lower.

This structural imbalance has trapped the spice industry in a dilemma of "producing aroma without generating revenue." Although Hainan's natural spices are superior in quality, flavor, and safety compared with synthetic alternatives—and command higher market prices—the actual income earned by farmers and processing enterprises remains limited. For example, a company in Zhejiang Province produces approximately 6,000 tons of synthetic vanillin annually and exports it worldwide. In contrast, although Hainan's natural vanillin sells at prices several dozen times higher than synthetic products, insufficient high-end processing and product development capacity has prevented these advantages from being translated into substantial industrial gains.

3.2 Insufficient Market Expansion and Lagging Brand Development

The market for Hainan's green food and spice products has not been fully developed, resulting in a relatively small industrial output value and underutilized growth potential. Although research institutions such as the Spice and Beverage Research Institute have developed a variety of innovative products, enterprise participation in industrialization remains limited. A common phenomenon is strong interest but weak concrete action. Lagging brand development represents a major bottleneck in the industry, as Hainan lacks nationally influential and widely recognized spice brands.

Taking chili peppers as an example, Hainan is the largest chili-producing region in China, with an annual output of approximately 30,000 tons, accounting for more than 96% of the national total. However, due to backward local processing technologies, the absence of strong brand building, and insufficient product quality stability, most green spice products are positioned in low-end markets. Meanwhile, foreign markets tend to import processed chili products from other regions rather than directly sourcing from Hainan.

Another constraint on industrial development is the weak intensity of local market promotion. Hainan receives over 12 million tourists annually and is home to national 4A-level tourist attractions such as the Xinglong Tropical Botanical Garden. Nevertheless, spice product sales remain largely confined to tourist sites and have failed to enter mainstream distribution channels such as supermarkets, wholesale markets, and

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e-commerce platforms. As a result, brand premium effects are difficult to establish, and the overall industrial benefits—particularly those associated with tourism-related resources such as the Xinglong Tropical Botanical Garden—remain underdeveloped.

3.3 Weak Policy Implementation and Inefficient Technology Transfer

Although the Hainan provincial government has introduced multiple supportive policies, shortcomings persist in policy implementation. In the promotion of the "Three Products and One Indication" (green food, organic products, geographical indications, and quality certification) initiative, some cities and counties lack well-established working mechanisms, full-time personnel, and stable funding. This has led to insufficient technical services and guidance for enterprises, thereby weakening their motivation to participate in certification programs.

A disconnection also exists between technological research and the commercialization of scientific 成果. While research institutions such as the Spice and Beverage Research Institute have achieved numerous technological breakthroughs, the overall rate of technology transfer remains low. Many innovations remain at the laboratory stage and have not been scaled up for industrial production or market application. Cooperation among research institutions, enterprises, production bases, and markets is insufficient, resulting in poor alignment between research directions and actual market demand. Consequently, the industry struggles to form competitive products. Overall technological innovation capacity remains weak, particularly in deep processing and high–value-added product development. Despite Hainan's abundant spice resources, most products are still sold as raw materials or primary processed goods, leading to low added value and preventing resource advantages from being converted into economic advantages.

3.4 Multiple Challenges to Sustainable Development

A major bottleneck restricting the expansion of Hainan's spice industry is the severe limitation of land resources. The province's limited arable land constrains the large-scale expansion of spice cultivation. At present, the Spice and Beverage Research Institute has conducted innovative scientific trials of under-forest cultivation models in the Xinglong Tropical Botanical Garden in Wanning. Plans are underway to promote this model across more than 9 million mu of idle land beneath rubber, coconut, and areca nut plantations throughout the province in order to alleviate land-use pressures. However, large-scale implementation will require a prolonged period of experimentation and evaluation.

Environmental protection pressures are also increasing. Wastewater, exhaust gases, and other pollutants generated during spice cultivation and processing pose potential environmental risks. Balancing industrial development with local ecological protection has become a critical issue for the sustainable development of Hainan's spice industry. If not properly managed, Hainan's unique ecological environment could be severely damaged.

In addition, insufficient integration across the industrial chain has become increasingly evident. Weak linkages among cultivation, processing, and sales stages—often disconnected from real market conditions—limit the overall competitiveness of the industry. As a result, industrial chain efficiency remains low, and synergies and economies of scale are difficult to achieve.

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4. Countermeasures for the Development of Hainan's Green Food and Spice Industry

4.1 Building a Full Industrial Chain Development Model

To address structural imbalances in the local spice industry, Hainan should establish a full industrial chain development model that integrates cultivation, research and development, processing, marketing, tourism, and cultural industries, ensuring coordinated development across all stages. Against the backdrop of the Hainan Free Trade Port, an international spice trade zone should be developed. Leveraging the policy advantages of the Free Trade Port, Hainan can build a China International Spice Trade Zone encompassing cultivation, R&D, production, logistics, and marketing, thereby improving the completeness of the industrial chain and enhancing industrial concentration and market competitiveness.

Efforts should also be made to promote the integrated development of the tertiary sector. Drawing on the successful experience of the Xinglong Tropical Botanical Garden, the spice industry can be closely combined with tourism, culture, and wellness industries to develop science popularization tourism and leisure agriculture. Tourism scenarios can serve as effective platforms for product sales and brand promotion.

In addition, under-forest cultivation models should be widely promoted. By making full use of more than 9 million mu of idle land under economic forests, Hainan can scale up spice crop cultivation, break through land resource constraints, and improve comprehensive land-use efficiency.

Table 2. The Integrated Industrial Chain of Hainan's Spice Industry

Industrial Chain Stage	Development Focus	Specific Measures	Expected Outcomes
Cultivation	Under-forest cultivation; ecological farming	Utilize idle land beneath economic forests for large-scale cultivation and promote ecological planting technologies	Alleviate land constraints; improve cultivation efficiency and product quality
R&D	Deep-processing technologies; product innovation	Prioritize the development of high–value-added products and strengthen industry–university–research collaborative innovation	Enhance technological content and value added of products
Processing	Green processing; standardized production	Promote the "Three Products and One Indication" certification system and establish standardized processing regimes	Improve product quality and market recognition
Marketing	Brand building; diversified channels	Develop a regional public brand and expand mainstream channels such as e-commerce and commercial supermarkets	Expand market coverage and brand influence
Tourism	Agritourism; immersive experiences	Create spice-themed tourism destinations and develop immersive experiential projects	Increase product visibility and consumer loyalty
Culture	Inheritance and dissemination of spice culture	Organize spice culture forums, exhibitions, and related events; explore and showcase the cultural connotations of Hainan spices	Strengthen cultural foundations of the industry and enhance brand value

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4.2 Strengthening Scientific Research and the Commercialization of Research Outcomes

Technological innovation should be positioned as the core driving force for enhancing the technological intensity of the industry and improving the efficiency of research commercialization, thereby strengthening overall industrial competitiveness.

Increasing investment in research and development. Enterprises should be encouraged to establish in-house R&D institutions. For enterprises above a designated scale, incremental annual R&D investment ranging from RMB 50,000 to RMB 500,000 should be incentivized through targeted subsidies. High-tech industrial enterprises and other qualified high-tech firms should receive subsidies of up to RMB 2 million and RMB 1 million, respectively, calculated at 30% of their annual increase in R&D expenditure, in order to stimulate innovation vitality.

Deepening industry–university–research collaboration. An integrated innovation system linking research institutions and enterprises should be established to encourage researchers to engage directly in enterprise-based R&D activities. This approach will improve alignment between research outputs and market demand and accelerate the industrial application of scientific and technological achievements.

Focusing on high–value-added product development. Priority should be given to the development of natural spice extracts, high-end food additives, flavorings, and perfumes. By extending the industrial chain and increasing product value added, the long-standing challenge of "abundant resources but low economic returns" can be effectively addressed.

Introducing advanced technologies and equipment. Leveraging the Free Trade Port's zero-tariff policy, international advanced spice-processing equipment and technologies should be imported to upgrade production processes, enhance efficiency, and improve product quality.

4.3 Expanding Policy Support and Strengthening Brand Development

A favorable development environment should be cultivated through a sound policy support system and enhanced efforts in brand development.

Ensuring the implementation of fiscal incentive policies. Policies related to green food certification subsidies and rewards for achieving production value milestones should be strictly enforced, with funds disbursed in a timely and sufficient manner to stimulate enterprise participation in production and innovation.

Implementing preferential tax policies. In accordance with Free Trade Port regulations, eligible enterprises in encouraged industries that are registered and operating in Hainan should benefit from a reduced corporate income tax rate of 15%. These measures significantly lower operating costs and attract more enterprises to participate in the spice industry.

Strengthening brand cultivation. Green food certification should be established as a prerequisite for applying for the "Hainan Fresh Products" designation, with strategic focus placed on advantageous varieties such as agarwood. Regional public brands should be developed, and industry exchange platforms should be created through events such as the Agarwood Tourism and Trade Expo and the World Spice Industry and Spice

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Culture Forum to enhance brand visibility and influence.

Improving market supervision mechanisms. A comprehensive annual inspection system for "Three Products and One Indication" certifications should be established. Enterprises failing to meet standards should have their certifications revoked and publicly disclosed. Strict enforcement should be applied against the misuse or overextension of certification labels to safeguard market order and brand credibility.

4.4 Promoting Sustainable Industrial Development

Adhering to a green development philosophy, coordinated progress between industrial growth and ecological conservation should be pursued to ensure long-term sustainability.

Promoting ecological cultivation models. The use of chemical pesticides and fertilizers should be reduced through the adoption of eco-friendly practices such as biological pest control and organic fertilizer substitution, thereby protecting soil and water resources and maintaining ecological balance.

Developing a circular economy. Resource utilization of spice crop residues should be promoted by processing post-extraction waste into organic fertilizers or animal feed, achieving resource recycling and reducing environmental impact.

Strengthening ecological environmental protection. Environmental standards for spice cultivation and processing should be formulated, and pollutant discharge should be strictly regulated to ensure that industrial development does not compromise Hainan's fragile ecosystem.

Advancing sustainable development certification. Enterprises should be encouraged to obtain green food and organic product certifications, guiding the industry toward a low-carbon, sustainable development pathway and enhancing market competitiveness.

5. Conclusion and Outlook

Hainan's green food spice industry benefits from exceptional natural resource endowments, a favorable policy environment, and substantial market potential. Nevertheless, it faces significant challenges, including structural imbalances, insufficient market expansion, weak technology commercialization, and mounting pressures on sustainable development. Going forward, Hainan must establish a new integrated industrial chain development model, strengthen scientific research and the transformation of high-quality research outcomes, intensify policy support and local brand building, and promote sustainable development practices. These measures will enable Hainan to fully leverage the resource and policy advantages of the Free Trade Port and overcome existing development bottlenecks.

With the continued advancement of the Hainan Free Trade Port and the sustained global growth in demand for green and health-oriented consumption, the green food spice industry in Hainan is poised to achieve a fundamental transformation from "producing aroma" to "creating value." It is expected to become a distinctive pillar industry and a flagship brand of Hainan's economy. Future efforts should focus on four key priorities: advancing the development of high–value-added products through continuous technological innovation; expanding international markets by leveraging Free Trade Port policies and strengthening processing-oriented

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exports; intensifying brand-building efforts to enhance product recognition and reputation; and upholding ecological red lines to ensure harmonious coexistence between industrial development and environmental protection.

With concerted efforts from all stakeholders, Hainan's green and organic food spice industry is expected to embrace a broader development horizon, making greater contributions to high-quality economic growth under the Free Trade Port framework and to increasing farmers' incomes. This will further support the construction of Hainan as an "International Spice Island" and a "Global Agarwood Hub," revitalizing the brand image of the "Kingdom of Spices."

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