Research on the Integration of Traditional Sichuan Roast Duck with Molecular Cooking Techniques and Its Industrial Application in the Context of New Agricultural Sciences

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Abstract

In the context of consumption upgrading, integrated development of new agricultural science industries, and young consumers' pursuit of distinctive dining experiences, the traditional braised and roasted poultry industry is confronted with multiple market difficulties. These challenges mainly include product homogenization, demographic segmentation among consumers, and low added value brought by conventional production techniques. This study examines a university student innovation project - "Molecular Cuisine Roast Duck" - which combines Sichuan's traditional roast duck preparation methods with modern molecular cooking technologies. By integrating techniques like reverse globularization, liquid nitrogen freezing, air foaming, and slow-cooking at low temperatures, the project has developed an innovative composite roast duck product system. The research conducts in-depth analysis across multiple dimensions - including market pain points, technological frameworks, diversified business models, risk management, industry-academia collaboration, and rural employment opportunities. It establishes an integrated industrial development pathway combining "traditional agricultural ingredients + modern food technology + online-offline retail + franchise operations". The findings demonstrate that integrating traditional prepared foods with molecular cuisine effectively enhances agricultural product value, expands the youth consumer market, and leverages university innovation resources to create replicable entrepreneurial models for deep processing of traditional braised dishes and roasted poultry products. This research also provides both practical insights and theoretical references for relevant industrial development.

Keywords

New agricultural sciences, Molecular cuisine, Sichuan-style roast duck, Deep processing of agricultural products, Industrial development, Industry-academia collaboration

Introduction

Against the dual backdrop of new agricultural sciences and booming experiential catering, traditional Sichuan roast duck faces structural bottlenecks such as single product forms and insufficient consumer attraction. Existing studies mostly focus on either pure meat processing or independent molecular gastronomy, while few integrate regional classic poultry cuisine with molecular food techniques for industrialized exploration. Therefore, this study takes molecular roast duck entrepreneurial project as a carrier to explore a replicable industrial path combining traditional craftsmanship, modern food technology and retail operation.

Research background

Transformation of the consumer market: The rise of rational, personalized, and experience-based dietary needs

In the post-pandemic era, the consumption patterns of domestic residents have undergone significant transformation. Mass consumption has shifted from merely pursuing brand premium to favoring products with high cost-effectiveness, health benefits, and distinctive features. Catering consumption no longer solely serves basic hunger satisfaction; sensory experiences, creative visuals, and novel flavors have become core driving forces for young consumers [1].

New business models such as China-fashion cuisine, ready-to-eat meals, innovative fusion dishes, and molecular light cooking have rapidly gained popularity, demonstrating the substantial market potential of traditional cuisine combined with modern food processing technologies. The domestic prepared food industry generally suffers from homogenization, consumer segmentation and low added value [2]. Traditional roast duck, as a classic prepared food item, has long faced challenges such as fixed taste profiles, limited variety, an aging customer base, and weak product premiumization capabilities. These drawbacks make it difficult to meet the personalized demands of emerging consumer groups like urban white-collar workers in the new era.

The new agricultural science strategy promotes innovation in the deep processing of agricultural products

The National New Agricultural Science and Technology Initiative promotes interdisciplinary integration among agriculture, forestry, food science, cultural tourism, and engineering. It encourages innovation in deep processing of distinctive livestock and agricultural products to extend the agricultural value chain and enhance product added value. Cherry Valley lean meat ducks, as raw materials for large-scale farming, are primarily distributed as whole ducks or semi-finished products at lower price points, with insufficient supply of creatively processed products. Combining traditional Sichuan-style duck curing, marinating, and oil-dipping techniques with molecular food technology represents a typical high-value-added deep-processing approach for livestock products, aligning well with the policy direction for integrated development of the new agricultural science sector [3].

The civilian adoption of molecular cooking techniques has lowered the barriers to implementing innovative culinary concepts

Early molecular gastronomy techniques - including liquid nitrogen cryopreservation, sodium alginate globulation, spray drying, gelatinization, and air foaming - were primarily employed in high-end Michelin-starred restaurants. With the industrial-scale production of food processing equipment and edible chemical raw materials, technology costs have steadily declined, making these methods viable for expansion into mainstream catering markets and providing technical support for innovating traditional roasted poultry dishes [4].

Research meaning

Theoretical significance

Enriching the innovative research framework for deep processing of livestock and poultry agricultural products under the perspective of modern agricultural science, filling the academic gap in integrating traditional Sichuan-style roast duck with modern molecular cooking techniques. It establishes a three-dimensional theoretical framework combining "traditional culinary craftsmanship + molecular food technology + new retail business models". This framework provides a theoretical model for the modernization of Chinese traditional prepared foods and the creative development of specialty agricultural products.

Practical significance

First, addressing the industry challenges of traditional roast duck businesses - including product homogeneity, limited customer base, and narrow profit margins - by developing differentiated and innovative catering offerings. Second, expanding the meat duck farming value chain to create employment opportunities across upstream breeding, downstream processing, logistics, and restaurant franchising, thereby boosting income for rural agricultural and sideline industries. Third, establishing university-industry-academia collaboration platforms that integrate food science education, technology development, and industrial implementation through student innovation projects, fostering versatile new agricultural science professionals. Fourth, developing replicable and scalable small-scale catering entrepreneurship models that provide comprehensive implementation frameworks for university-based agricultural startup teams.

Research content and methods

Research content

This paper takes the innovative entrepreneurial project of molecular-style roast duck as a core case study and systematically conducts the following analyses.

(1) Identification of industry market pain points.

(2) Breakdown of product process technology systems.

(3) Development of diversified business models.

(4) This is a strengths, weaknesses, opportunities, threa-

ts (SWOT) competitiveness analysis.

(5) Comprehensive risk assessment and mitigation.

(6) Financial and financing planning.

(7) Industry-academia-research collaboration for talent cultivation and employment promotion.

(8) Long-term industrialization development strategy research.

Research methods

(1) Case analysis method

Using the molecular cuisine roast duck project from this university's innovation competition as the core case study, and incorporating operational data from multiple innovative roast duck restaurants across China. This approach identifies existing challenges in the innovative development of traditional roast duck cuisine and proposes optimization pathways.

(2) Market research method

Analyzing emerging trends in creative dining consumption, dietary preferences among young demographics, and the market size and growth prospects of molecular cuisine.

(3) Political, economic, social, technological (PEST) and SWOT analysis methods

Analyzing the industry environment from policy, economic, social, and technological perspectives to identify the projects strengths and weaknesses, as well as external opportunities and competitive threats.

(4) Literature review method

Conducting a systematic review of domestic and international literature on the development of new agricultural sciences, deep processing of agricultural products, molecular food technology, and new retail in the catering industry to strengthen the theoretical foundation of the study.

Analysis of the current market situation and key challenges in the industry

Existing market issues in the traditional duck roasting industry

(1) Conflict between costs and pricing, resulting in narrow profit margins

Traditional roast duck restaurants rely on selling whole ducks, resulting in meager profit margins per item. The limited supply of premium liquid nitrogen-roasted ducks is currently available on the market. These products are primarily offered in upscale dining establishments, where equipment costs, liquid nitrogen expenses, and professional chef fees are substantial. Each serving of such roast duck is priced at several hundred yuan, forming a high price barrier. This barrier discourages repeat purchases by average consumers and limits the overall customer base size. Budget-friendly roast duck offerings lack distinctive value propositions, while rising costs for raw materials, rent, and labor continue to erode profits.

(2) There is a clear stratification in consumer acceptance levels across different customer segments.

The middle-aged and elderly consumer demographic remains committed to traditional roast duck flavors and resists modern processing techniques such as liquid nitrogen immersion, gel coating, or foam application. In contrast, younger consumers seek novel experiences. However, traditional roast duck establishments lack visual and sensory innovations, failing to attract this demographic. The industry has long suffered from a persistent gap characterized by "retained loyal customers while new customers are lost".

(3) There is a significant shortage of professional technical personnel, and standardized production poses considerable challenges.

Molecular cooking requires extremely stringent precision in terms of temperature control, ingredient ratios, and operational procedures. There is a scarcity of versatile chefs in the market who combine traditional braising and grilling techniques with expertise in molecular food preparation. Most small-scale catering establishments lack standardized molecular cooking protocols, resulting in inconsistent product quality and difficulties in scaling up operations.

Analysis of the underlying causes of pain points

(1) Iterative enhancement of consumer demand

Residential food consumption has evolved from basic physiological needs to encompass multifaceted demands for sensory experiences, social interaction, and health benefits. Trendy dining spots, unique culinary experiences, and low-fat healthy options have become central priorities in the food service sector. Traditional roast duck, with its limited flavor profile and single consumption format, fails to meet these emerging consumer expectations.

(2) Rapid popularization of food processing technology

The industrial-scale production of molecular food ingredients, low-temperature control equipment, and liquid nitrogen refrigeration systems provides the

technical foundation for upgrading traditional prepared foods, demonstrating technical feasibility for innovation in the catering industry [5].

(3) Comprehensive promotion of healthy dietary concepts

Modern consumers are highly concerned about their intake of cooking oils and salt. Molecular cuisine can minimize fat leaching in roast duck through precise ingredient control and low-temperature slow-cooking techniques, aligning with the trend for low-fat, low-salt healthy diets. This advantage is something traditional roast ducks, which rely heavily on oil and brine, lack.

Market development prospects for molecular cuisine combined with roast duck

First, the market boasts substantial growth potential: Gen Z, urban middle-class consumers, and food enthusiasts form a stable target demographic, with young people demonstrating high acceptance of innovative cuisine and strong purchasing intent.

Second, product diversification offers significant expansion potential: By incorporating regional flavors and seasonal themes, companies can launch derivative products such as jelly, ice cream, molecular spheres, and foam, thereby continuously enriching their product portfolio [6].

Third, it possesses strong potential for international expansion: By combining modern molecular cuisine with Chinese and Western culinary traditions, Chinese roast duck offers a unique competitive edge that enables it to penetrate global catering markets.

The technical framework and product advantages of molecular cooking duck roast products

Basic processes: Standardized production procedure for traditional Sichuan-style roast duck

The project uses Cherry Valley lean-flesh fresh ducks as its core ingredient and establishes a standardized traditional marinating and roasting process.

Raw material pretreatment: Fresh ducks are cleaned and deboned to ensure freshness and hygiene of the ingredients.

(1) Compounding spice marination: Using a customized natural spice blend package, soak in cold water for over 12 hours to allow full flavor absorption, marinade formula directly affects meat flavor, tenderness and food safety [7].

(2) Brining preparation method: Using standardized ratios of brine ingredients mixed with water, cooking at a constant temperature, then hanging to drain excess moisture.

(3) Slurry application and air-drying: Applying a uniform mixture of starch and sesame seed slurry to the duck body, then allowing it to dry naturally under adequate ventilation.

(4) Hot oil coating: Hot oil is applied in multiple layers at a constant temperature to create a crispy, glossy exterior while preserving the duck meat's juicy texture.

The entire process employs standardized, quantitatively defined ratios based on traditional techniques, ensuring consistent and uniform flavor in premium roast duck while providing a solid foundation for secondary processing in molecular cuisine [8].

Innovative technologies: Six derivative processes for molecular cuisine

Leveraging modern molecular food technology and the application principles of thickening food additives in molecular gastronomy, six innovative derivative products have been developed based on the traditional roast duck foundation, forming a comprehensive product portfolio (see Table 1) [9].

Table 1. Innovative derivative roast duck products based on molecular gastronomy technology.

Product name	Technical principle & characteristics	Application features / sensory experience
Roast duck jelly	Agar/gelatin solidifies the duck soup sauce, resulting in a smooth, tender, and flavorful texture.	As a pre-meal appetizer snack
Roast duck with air foam	Air-pressurized air treatment for duck broth, resulting in a light and velvety texture.	Pairing it with duck slices adds extra layers of flavor
Roast duck with liquid nitrogen ice cream	Ultra-low temperature frozen duck meat/sauce, cool and tender.	Adapted for summer consumption scenarios
Roast duck flavor microcapsules	The secret duck sauce can be wrapped in edible film.	The moment you bite into it, a rich aroma of meat is released instantly.

Product name	Technical principle & characteristics	Application features / sensory experience
Reversed molecular ball for roast duck	Sodium alginate and calcium chloride solutions are used to encapsulate the duck brine broth.	Juicy and chewy
Low-temperature slow-cooked roast duck	Precise temperature control during prolonged low-temperature cooking to preserve freshness with minimal fat content	The meat is tender and delicate.

Core competitive advantages of the project product

(1) Barriers to differentiated innovation

Few comparable roast duck products on the market integrate a complete set of molecular cooking techniques. Through thousands of trials, this product has developed a unique combination of proprietary spice formulations and standardized molecular processing procedures. This feature sets it apart from standalone liquid nitrogen-roasted duck offerings and establishes an industry-leading product portfolio diversity.

(2) A layered pricing system that offers high cost -effectiveness and profitability

Set profit margins based on classification of molecular process consumables and operational complexity, balancing affordable base models with premium creative variants.

a) Traditional roast duck

Each bird generates a profit of 15 yuan, meeting the daily consumption needs of the general public.

b) Reverse globular assembly meal kit

The reverse globular assembly meal kit generates a profit of 25 yuan per serving, requires minimal consumables, and has moderate operational complexity.

c) Liquid nitrogen ice cream creative package

The liquid nitrogen ice cream creative package generates a profit of 35 yuan per serving, but the liquid nitrogen consumption is relatively high in cost.

d) High-end Air Foam Package

Each unit generates a profit of 40 yuan and requires the highest level of craftsmanship precision.

Prices are dynamically adjusted in response to fluctuations in raw materials, rent, and labor costs; price elasticity is low, ensuring stable market competitiveness.

(3) Comprehensive intellectual property protection across the entire value chain

The project plan encompasses 10 specialized patents covering the entire value chain. These patents range from production processes and dedicated equipment to composite seasonings, cold-chain packaging, intelligent control systems, nutritional enhancement, food safety testing, and process optimization. Such intellectual property layout establishes barriers to mitigate risks of technological imitation by competitors. The patent portfolio includes the following categories:

a) Molecular cooking methods for roast duck preparation

b) Specialized culinary equipment

c) Composite spice formulations

d) Eco-friendly preservation packaging

e) Cold-chain temperature control systems

f) Intelligent cooking regulation systems

g) Multi-flavor enhancement formulas

h) Low-fat nutritional fortification techniques

i) Rapid food safety testing methods

j) Standardized process optimization solutions

(4) Health attributes enhance product value

The low-temperature slow-cooking process with precise salt and oil control reduces the fat and sodium content of traditional roast duck, aligning with modern healthy dietary needs and distinguishing it from conventional roast poultry products high in oil and salt.

Building a diversified business model for molecular cuisine-style roast duck dishes

This project adopts a four-dimensional integrated profit model comprising direct product sales, franchise operations, customized corporate services, and supply chain value-added services, effectively bridging short-term cash flow needs with long-term scalability expansion.

Core profit channel 1: Direct online and offline product sales

Offline channels: Physical retail stores offering creative molecular roast duck packages and whole traditional

roast ducks for sale.

Online channels: TikTok, Meituan, Ele.me food delivery platform, WeChat mini-program online stores, and e-commerce retail pre-made semi-finished products.

Profit model: Leveraging product differentiation and visual creativity to create a viral appeal, boost average transaction value, and ensure sustained profitability per item.

Core profit channel 2: Brand chain franchise operation

A standardized franchise system is available for catering entrepreneurs, with three primary revenue sources: brand franchise fees, annual brand management fees, and profit margins from unified supply chain raw material procurement. The headquarters provides a comprehensive suite of technical patents, standardized operating manuals, online/offline marketing strategies, store interior design solutions, and cold-chain logistics support, enabling rapid brand expansion at scale.

Core profit channel 3: Customized catering services for government and enterprises

Customized molecular duck banquet services creative dish development and live molecular cuisine demonstrations are available for enterprises banquets and food exhibitions. Fees cover customized planning, dish preparation, and on-site technical support, thereby expanding business-to-business (B2B) revenue streams.

Fourth auxiliary profit channel: Value addition through supply chain integration

Conducting centralized bulk procurement of meat ducks, spices, and molecular food ingredients, establishing long-term partnerships with upstream aquaculture producers and food ingredient manufacturers to reduce unit purchase costs. Establishing a standardized cold chain logistics system to minimize product loss, and optimize the supply chain to cut operational costs, thereby indirectly enhancing overall net profit.

Supporting operational support system

(1) Customer relationship management

Building a member database, implementing a points-based loyalty program with repurchase incentives, and refining products through user data analysis.

(2) Sustainable development system

Utilizing biodegradable, eco-friendly packaging throughout the entire process, collaborating with local duck farmers, and supporting the development of rural agricultural and sideline industries [10].

(3) Financial investment management

Calculating revenue, costs, and net profit in phases, compute return on investment (ROI), and dynamically adjusting business strategies.

Comprehensive analysis of project SWOT competitiveness

Strengths

(1) Technological innovation advantage

By integrating traditional Sichuan-style roast duck with comprehensive molecular cooking techniques and relying on innovative intelligent meat processing technologies to realize differentiated product upgrading, the product boasts unique visual appeal and distinctive flavor profile [11].

(2) Intellectual property advantages

Ten patents covering the entire product lifecycle have been developed to establish robust technical barriers against competitor imitation.

(3) Layered pricing advantage

Comprehensive coverage of high-, mid-, and budget-friendly product lines, catering to both mass consumers and upscale dining events.

(4) Team innovation advantages

The undergraduate startup team possesses strong innovation and research and development (R&D) capabilities, is supported by experienced entrepreneurship mentors, and benefits from robust university-level scientific research resources.

Weaknesses

(1) High operating costs

Specialized equipment for molecular cuisine, liquid nitrogen, and professional staff requirements significantly increase initial investment expenses.

(2) There are barriers to audience acceptance

Middle-aged and elderly traditional diners show limited openness to modern molecular cuisine.

(3) Technical barrier

Training comprehensive molecular cuisine chefs requires a prolonged period and entails high personnel recruitment costs.

Opportunities

(1) Policy opportunities

New Agricultural Science policies and support measures for college students' innovation and entrepreneurship

allow applicants to receive competition awards, startup subsidies, and venue assistance.

(2) Market opportunities

The demand for creative dining among young consumers continues to grow, with substantial traffic benefits from viral food trends.

(3) Cross-sector opportunities

Collaborating with food bloggers, supermarkets, cultural tourism destinations, and restaurant brands through joint ventures.

(4) Technological opportunity

Molecular food processing equipment continues to become more affordable, with significant potential for long-term cost reduction.

Threats

(1) Industry competition threat

The roast duck market is mature, with traditional roast duck restaurants and modern braised meat shops competing for customers.

(2) Consumer preference risk

Young consumers dietary trends evolve rapidly, and product novelty diminishes over time.

(3) Compliance threats

Regulations governing food safety production and cold-chain storage/transportation continue to be refined, driving up compliance costs.

(4) Imitation competition threat

Simple molecular cuisine dishes can easily be replicated by competitors at low cost.

Comprehensive risk identification and response strategies across all dimensions of the project

Financial risks and countermeasures

(1) Risk profile

The project requires substantial and sustained investments in initial equipment procurement, raw material stockpiling, market promotion, and store renovation. If revenue falls short of expectations, this could lead to cash flow shortages, resulting in disrupted raw material supplies, staff turnover, and stalled marketing efforts.

(2) Response plan

a) Diversified financing channels

The team raises startup capital independently and applies for intellectual property-backed loans from financial institutions using patented technologies. It also actively participates in national university innovation and entrepreneurship competitions as well as new agricultural science entrepreneurship contests to secure competition grants.

b) Refined fund management

Developing monthly cash flow budgets, establish a fund early-warning mechanism, and strictly control non-essential expenditures.

c) Phased expansion strategy

Prioritizing establishing small pilot experience stores to validate the profitability model before scaling up operations, thereby reducing substantial upfront costs.

Market risks and countermeasures

(1) Technological imitation risk

Accelerating the approval of 10 patent applications and continuously iterating new products, developing brand intellectual property (IP) and exclusive flavor formulations to establish a competitive differentiation barrier through brand reputation.

(2) Risk associated with limited target market size

Expanding into the family-oriented affordable semi-finished products and corporate banquet B2B markets, developing lightweight, family-friendly snack options suitable for all ages, and broadening the customer base.

(3) Risks associated with insufficient consumer trust

Implement transparent operational procedures offline; publishing short videos online detailing ingredient traceability and cooking processes, organizing free tasting events, and promoting food safety knowledge related to molecular cuisine.

Technical and supply chain risks and their mitigation strategies

(1) Technological iteration risks

Establishing long-term industry-academia-research collaboration with university food science programs, form dedicated R&D teams, and continuously monitoring emerging technologies in the molecular food industry.

(2) Supply chain instability risk

Establishing 2-3 alternative suppliers for meat ducks and molecular raw materials to diversify procurement channels. Setting up proprietary cold-chain storage facilities with real-time monitoring of food temperature during storage and transportation to minimize losses.

Internal management risks and their mitigation strategies

(1) Risk of core technical talent turnover

Establishing a tiered compensation system, equity incentive programs, and innovation reward mechanisms to improve employee career advancement pathways. Developing standardized operating manuals to document technical processes and mitigate the impact of personnel turnover.

(2) Decision-making risk mitigation

Establishing a four-tier decision process ("market research - data analysis - team discussion - supervisor review") to adjust products and marketing strategies based on consumer data.

(3) Food compliance risks

Regularly organizing comprehensive food safety regulatory training for all staff, establish standardized procedures for raw material testing and finished product sampling, and dynamically monitor updates to food industry regulatory policies.

Organizational structure, teams, and the industry-academia-research collaborative education model

Organizational structure for enterprise standardization

Upon successful industrialization, the project will establish six functional departments with clearly defined roles and responsibilities.

(1) General manager

Overseeing the overall strategy, investment and financing, and cross-departmental coordination.

(2) Technical department

Responsible for molecular cuisine process development, equipment maintenance, patent applications, and product iteration.

(3) Sales and marketing department

Online and offline marketing, collaboration with influencers, customer acquisition at physical stores, and user engagement management.

(4) Production department

Standardized processing of roast duck, food quality inspection, and finished product manufacturing.

(5) Finance department

Collaborating with third-party professional accounting firms to manage cash flow, cost accounting, and investment/financing projections.

(6) Franchise development department

Negotiation with franchisees, operation of the franchise system, and support for store establishment.

Entrepreneurial teams and mentoring faculty

The core team consists of undergraduate students majoring in new agricultural sciences, possessing comprehensive expertise in food process development, marketing, and supply chain management, with outstanding capabilities in innovative R&D and practical implementation. They are supported by experienced entrepreneurship mentors with extensive experience in catering entrepreneurship, competition guidance, and industry resource networking. These mentors actively participate throughout the project to refine technical solutions and optimize business models. They also provide professional guidance for industrialization. Meanwhile, they facilitate connections between university laboratories, industry investors, and resources across the catering industry chain.

Integration of industry, academia, and research in talent cultivation and employment promotion

(1) Leading innovation in new agricultural education

Establishing a campus-based molecular cuisine training laboratory and developing a specialized practical course titled "Molecular Deep Processing of Traditional Livestock and Poultry Products".

Organizing food science students to participate in the entire process of product development, market research, and store operations, bridging theoretical instruction with practical industry experience [12].

Collaborating with universities to conduct food processing research projects, leveraging industrial initiatives to support academic research and cultivate interdisciplinary innovative talents in new agricultural sciences.

(2) Creating jobs and increasing income throughout the entire supply chain

a) Direct employment

Our flagship stores, production workshops, leasing services, and marketing departments offer positions in kitchen operations, daily operations, sales, and technical training.

b) Upstream agricultural employment

Consistently sourcing raw materials from local meat duck farmers, expanding demand for livestock and

poultry farming, and boosting farmers' incomes.

c) Indirect entrepreneurship and employment

By opening franchise channels, it provides small and medium-sized entrepreneurs with a low-barrier pathway to start catering businesses, creating job opportunities across society.

Long-term industrial development planning

Short-term plan (to be implemented within 6 months)

Completing the selection of suppliers for upstream meat ducks, spices, and molecular food ingredients, and signing long-term stable supply agreements.

Refining the comprehensive standardized operational procedures for molecular cuisine, continuously iterate and optimizing product taste, while reducing operational complexity and material costs.

Establishing an online promotional matrix covering TikTok, Xiaohongshu, and WeChat; launch offline pilot experience stores; and complete opening marketing campaigns.

Collaborating with professional cold-chain logistics providers to establish standardized storage, preservation, and distribution systems, and strictly control product loss.

Medium-term plan (1-3 years)

Completing all 10 technical patent applications to establish a comprehensive intellectual property protection system.

Establishing open regional chain franchises, expanding physical stores across cities, and creating distinctive regional dining brands.

Expanding two key B2B channels - enterprise customization and supermarket-prepared semi-finished products - to boost revenue scale.

Strengthening industry-academia-research collaboration in universities, establishing on-campus training bases, and continuously developing innovative culinary dishes.

Long-term planning (3-5 years)

Optimizing the nationwide franchise network and establishing a leading brand in the roast duck segment that combines traditional Sichuan flavors with innovative molecular techniques.

Exploring collaborations in overseas catering services and international food exhibitions to promote the global adoption of innovative Chinese roast duck dishes.

Expanding the deep-processing industrial chain for livestock and poultry, developing derivative agricultural products such as duck meat snacks and ready-to-eat meals, and achieving diversified industrial development.

Conclusion

Using the molecular cuisine roast duck project developed by students from the New Agricultural Science College as a case study. This paper systematically demonstrates that integrating traditional Sichuan-style roast duck with molecular food technology offers significant market viability and industrial value.

First, traditional roasted poultry products, when subjected to advanced molecular gastronomy processing, can effectively overcome industry-wide homogeneity issues, enhance product premium value, and precisely meet the experiential dining demands of young consumers.

Second, the four-dimensional business model - combining direct retail, franchise chains, B2B customization, and supply chain value-added services - effectively balances short-term cash flow with long-term scalability, demonstrating strong sustainable profitability potential.

Third, the projects comprehensive patent portfolio across the entire value chain, tiered pricing structure, and integrated online-offline marketing strategy create multiple competitive barriers, effectively mitigating various operational risks in market, technology, capital, and management aspects.

Fourth, the project aligns closely with the policy promoting interdisciplinary integration in new agricultural sciences. It not only enhances income for upstream livestock farmers and creates social employment opportunities, but also establishes a university-industry-research training platform, achieving mutual empowerment between industrial development and talent cultivation.

Research prospects

The integration of traditional Chinese prepared foods with molecular food technology is still in its early stages domestically. Future research should focus on two key directions: First, optimizing the formulations of molecular cooking ingredients to further reduce production costs and promote creative roast duck dishes in county-level markets and mainstream catering sectors. Second, expanding studies on regional flavor fusion by

adapting Sichuanese, Cantonese, and Beijing-style roast duck recipes to molecular processing techniques, thereby developing innovative prepared food products with distinct regional characteristics. Concurrently, leveraging university innovation platforms to deepen efforts in agricultural product deep-processing, continuously refining industrialization models for modernizing traditional cuisine, and providing practical examples for the integrated development of new agricultural science industries.

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Conflicts of Interest

The authors declare no conflict of interest.

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