

Exploration of the Current Development and Future Trends of Functional Foods

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ABSTRACT

Functional food is a health driven industry that deeply couples nutrition science and food engineering technology. Its essence is the product of the integration and symbiosis of technological achievements in two major fields, and the development volume and innovation level have become the core standards for measuring the food industry's breakthroughs in traditional constraints and the realization of transformation and upgrading. The global functional food market is showing a steady expansion trend. In 2024, its volume will reach 1088.61 billion yuan, and it is expected to exceed 1.46091 trillion yuan by 2030, with a stable compound annual growth rate of 5.02%. China has performed outstandingly in the global market. In 2023, its market volume will reach 352.3 billion yuan, with an average annual compound growth rate of 6% from 2016 to 2023. It is expected to exceed 485.8 billion yuan in 2029. This article systematically reviews the global functional food market pattern and the characteristics of China's industrial development, deeply analyzes core driving factors such as technological innovation, raw material breakthroughs, and consumer demand, clarifies the evolution logic of the policy and regulatory system, focuses on exploring future development trends such as personalized nutrition and preventive health, and combines the industrialization practices of enterprises such as Yihai Kerry and Feihe to propose countermeasures and suggestions for high-quality industry development, providing theoretical reference for industrial upgrading and policy optimization.

KEYWORDS

Functional Foods; Market Status; Technological Innovation; Consumer Demand; Policy Regulation; And Development Trends.

1. INTRODUCTION

Against the dual backdrop of the "Healthy China 2030" national strategy and the upgrading of global health consumption, food consumption has undergone a deep transformation from traditional "satiety needs" to "health value-added". Functional foods have become a new growth pole in the food industry with their dual attributes of "basic nutrition+specific health benefits". From an academic definition, functional food is a food category that contains scientifically validated specific active ingredients and can provide consumers with health benefits beyond the basic nutritional range. Its core difference from ordinary food lies in the precise regulation of active ingredient content and systematic verification of health benefits. Compared with health products, it emphasizes more integration with daily dietary scenarios and does not require additional changes in consumption habits [1]. The core driving force for the expansion of functional food market worldwide is the rising demand of the elderly for chronic disease prevention and body function maintenance under the accelerated process of population aging, and the high incidence of chronic diseases such as hypertension and diabetes (according to the World Health Organization data, there are more than 1.3 billion hypertensive patients and 537 million diabetes patients worldwide), which has driven consumers to turn to

preventive health management and the growing demand for taking the initiative to improve their health status through dietary intervention after the general improvement of public health awareness. As the world's second largest functional food market, China presents distinct local development characteristics, with the expansion of the middle class driving consumption upgrading (the online health product market sales reached 91.96 billion yuan in 2023, of which health products with "blue hat" qualifications increased by 39.3% year-on-year, reflecting consumers' preference for compliant products). The new retail channels are restructuring the industry's sales ecosystem, with first tier cities and eastern coastal areas relying on consumer potential and health awareness endowments to dominate market trends. The penetration rate in inland areas is still less than 20%, but the annual growth rate exceeds 25%, and potential momentum is gradually being released.

The development of the industry is facing a series of prominent challenges - and these challenges are precisely the deviation between efficacy claims and scientific verification, the high external dependence on core functional materials, and the yet to be sound industry standard system. The interweaving of the three forms a real dilemma. This dilemma hinders the high-quality advancement of the industry.

This article focuses on four core dimensions: market status, technological innovation, consumer demand, and policy regulation. Its system deconstructs the foundation and context of the development of the functional food industry, predicts future trends, and provides practical reference and action guidance for industry participants.

2. THE GLOBAL MARKET PATTERN OF FUNCTIONAL FOODS AND THE DEVELOPMENT CHARACTERISTICS OF CHINA

In the global functional food market, a competitive pattern of "multipolar growth and deep segmentation" has been established - and the dual core driving market growth under this pattern is the differences in regional development and the continuous innovation of product categories. Vicentini et al. (2016) pointed out in their long-term trend study of the global functional food market that regional demand differentiation and category innovation are key forces driving the formation of market patterns. This conclusion provides early academic evidence for the continuity of the current "multipolar growth" pattern [2].

As a typical mature market, the retail performance of health food and beverage in the United States is also supported by data: according to SPINS monitoring, its total retail sales have reached \$320 billion in 2024, and there are predictions that this number will further climb to \$384 billion in 2028; Moreover, the efficacy segmentation pattern in the US market is particularly clear - driven directly by the 42% obesity rate among American adults, weight management products have consistently maintained high growth rates. In terms of the European market, the trend towards "natural and organic" consumption is prominent. Plant extract functional foods have occupied an important position in the regional market.

The Asia Pacific region is the fastest-growing region in the global functional food market. China is the core driving force for growth in the region, with a market volume of 352.3 billion yuan in 2023, and presenting three significant characteristics. Firstly, the category structure is diverse. From August 2023 to July 2024, the sales of traditional dosage forms such as tablets and capsules will reach 26.34 billion yuan and 25.57 billion yuan respectively, and the growth rate of new dosage forms such as gummies and tea drinks will exceed 60%. This data difference intuitively reflects the trend of diversified consumer demand; Secondly, there is significant differentiation in segmented markets, with sales of immune enhancement products reaching 5.33 billion yuan (a year-on-year increase of 11.9%), weight management products reaching 3.3 billion yuan (a year-on-year increase of 59.0%), and anti-aging products growing at a rate of 125%; The third issue is uneven regional development, with first tier cities contributing over 60% of market sales, while the product penetration rate in the

central and western regions is less than 20% but the annual growth rate exceeds 25%, demonstrating strong growth potential. More than 100000 enterprises worldwide participate in the competition of functional food market, with Chinese enterprises accounting for about 30% and the industry as a whole showing a dispersed feature of "big market, small enterprise". Top enterprises have made breakthroughs through technological innovation, Feihe Dairy has broken through the foreign monopoly pattern of six core raw materials including lactoferrin through technological breakthroughs, and Yihai Kerry has launched a series of functional foods based on plant sterols, both of which have promoted the competitiveness of local brands in the market. The sales channels are in a trend of "online dominance and multi-channel integration", and e-commerce channels are the main growth pole of the market. During the "618" e-commerce promotion in 2024, the online sales of anti-aging functional foods increased by over 300% year-on-year.

3. TECHNOLOGICAL INNOVATION AND BREAKTHROUGH PATH OF RAW MATERIALS FOR FUNCTIONAL FOODS

Technological innovation is the core driving force for the upgrading of the functional food industry, running through the entire chain from raw material development, production process optimization to product implementation. The global investment in research and development of functional foods continues to grow, with a scale of approximately 6 billion US dollars in 2024 and expected to exceed 7 billion US dollars by 2025. The proportion of R&D investment by Chinese enterprises continues to increase, and the R&D intensity (R&D investment/sales) of top enterprises exceeds 5%. The cross fusion of biotechnology and food engineering has spurred multiple technological breakthroughs. Feihe Dairy's "Fresh Extraction Technology for Milk Protein" achieves the localization of high-end milk protein raw materials through core processes such as fresh active low-temperature separation and chromatographic ultrafiltration. Third party testing shows that the biological utilization of related products has increased by 40% compared to traditional processes, breaking the monopoly of foreign enterprises on high-end milk base materials. The innovation of raw materials is showing a trend of "naturalization orientation, deepening of functionalization, and breakthrough in localization". Traditional medicinal and edible raw materials have been revitalized through modern technology. Yihai Kerry has collaborated with universities to conduct a synergistic study on soy protein and plant sterols. Randomized controlled trials have confirmed that the combination of the two can significantly improve lipid metabolism indicators. The related results have been transformed into plant sterol granules and other products, which have been included in the recommended directory of the National Health Commission's "Guidelines for Adult Hypertension Dietary Care". The research and development of new functional ingredients continues to advance, with probiotics, dietary fiber, and diacylglycerol (DAG) as the core directions. Euromonitor International predicts that the global probiotic market will reach \$60 billion by 2025, and Chinese companies have already aligned with international standards in strain screening and functional verification. The process of domestication of raw materials is accelerating, and Feihe has built the first domestic automated production line for lactoferrin, which can produce lactoferrin products with a purity of 95% and reach the international advanced level, solving the problem of "bottleneck" of this raw material [3]. Production process optimization focuses on the dual goals of "maintaining active ingredients and improving consumer experience". The application of microcapsule embedding and low-temperature spray drying technology can effectively solve the problems of easy oxidation and bad taste of functional ingredients. Probiotic products can achieve intestinal targeted release through microcapsule embedding, and the survival rate can be improved by more than 30%. Intelligent production promotes industrial efficiency upgrading, and Yihai Kerry has built a full chain industrial production line to achieve digital control from raw material extraction to finished product packaging. The first pass rate of products has been increased to 99.8%. The efficiency of technological transformation has significantly improved, and the glycerol diester oil preparation technology developed by Jiangnan

University has been successfully transformed into a fat reducing functional edible oil product and recognized in the clinical nutrition field.

4. CHANGES IN CONSUMER DEMAND AND MARKET SEGMENTATION OF FUNCTIONAL FOODS

The upgrading of consumer demand drives the transformation of the functional food market from "broad-spectrum supply" to "precise matching", and the trend of population stratification and demand differentiation is clear. According to the Magic Mirror Insight survey, there are significant differences in health demands among different generations: Generation Z focuses on weight management (accounting for 38% of their needs), skin health, and immune enhancement, promoting the growth of oral beauty and light health products. Soft candy formulations are the preferred choice, and sales in the 2024 Rolling Year (MAT) increased by 71.6% year-on-year; The millennial generation is concerned about energy supplementation and intestinal health, consuming functional tea drinks and probiotic drinks an average of 2.3 times a week; The baby boomer generation focuses on cardiovascular health (accounting for 35% of their needs), joint protection, and anti-aging. The penetration rate of "blue hat" health food exceeds 40%, according to Euromonitor International's report. Consumer behavior is characterized by "scientific orientation and scenario segmentation". Innova's 2024 survey showed that 52% of consumers improve their health through dietary intervention, and 86% focus on the scientific basis of efficacy, which forces companies to strengthen clinical evidence. For example, the lipid-lowering effect of Yihai Kerry plant sterol products has been verified by three tertiary hospitals and the results were published in the Chinese Journal of Clinical Nutrition. The consumption scene is fully penetrated, with breakfast scenes promoting high protein cereal bars, office scenes driving functional coffee, and sports scenes promoting the growth of protein supplements. For example, MET Rx breakfast granola bars contain 28-32 grams of protein, matching the needs of commuters. The transformation of purchasing channels and decision-making factors has made online the main touchpoint. According to the Magic Mirror Insight report, from August 2023 to July 2024, online health products accounted for 53.2%, and live streaming e-commerce promoted impulse consumption. Star Map data shows that the online growth rate of weight management products during the "618" shopping festival in 2024 was 87.3%. Price sensitivity stratification, according to Euromonitor research, the group with an annual household income of over \$100000 places greater emphasis on health value and prioritizes efficacy, while ordinary consumers focus on cost-effectiveness, driving differentiated pricing for businesses. Building trust is key, and products with authoritative certifications (such as "Blue Hat" and FDA) have a higher growth rate. The white paper from Food Partner Network shows that the online sales of "Blue Hat" will increase by 39.3% year-on-year in 2024, surpassing non certified products by 18.6 percentage points. This phenomenon stems from the support of functional food regulation system to market trust - Functional Food Regulation System: Regulation Paradigm Proposed by Functional Food Center (2023), which points out that the current regulation paradigm has built a closed-loop of "standard setting - efficacy review - certification landing - market supervision", and "blue hat" certification needs to pass three core links: toxicological testing, stability research, and multi center clinical verification. This strict regulation makes certified products the first choice for consumers to avoid the risk of "efficacy false label" [4].

5. POLICY REGULATORY SYSTEM AND INDUSTRY STANDARDS FOR FUNCTIONAL FOODS

The improvement of policy supervision has clarified the "safety bottom line" and "development red line" for the functional food industry, and formed a global trend of "classified supervision and standard coordination". China has established a multi-level regulatory framework with the Food Safety Law as the core and the Management Measures for Registration and Filing of Health Food as

the support. Early research (2008) proposed that functional food health claims need to be scientifically validated through "functional evaluation procedures" and "toxicological assessments", laying the foundation for subsequent regulatory frameworks [5]. By 2024, the list of raw materials and the scope of efficacy claims will be refined, and 98 functional ingredients will be included in the allowed list. At the same time, the requirements for production qualifications and efficacy verification will be raised to increase the entry threshold and promote the exit of small and medium-sized enterprises lacking scientific evidence. The "Blue Hat" is the core compliance label of the product, and its market recognition has increased. According to the "2024 Functional Food Industry White Paper", the online sales of "Blue Hat" products reached 17.5 billion yuan in 2024, a year-on-year increase of 39.3%, which is higher than the industry average growth rate. There are regional differences in international regulatory models, but there is significant convergence in coordination. The United States implements a "filing system+health claim review", and the FDA requires health claims to be based on recognized and verifiable scientific evidence. In 2024, five new categories of claims, including "metabolic management" and "emotional health", will be added; The EU adopts a "pre-approval system", and the EFSA functional ingredient assessment standards are widely used by most countries around the world due to their scientific rigor; Japan has implemented a "specific health food" system, emphasizing the integration of functionality and daily diet, and emphasizing health assistance rather than treatment. Regional differences drive companies to adopt a "global standard+regional adaptation" compliance strategy, such as Nestle's Vital Pursuit series, which can simultaneously meet FDA and EFSA standards and achieve multi market layout. In terms of policy support, innovation in the functional food industry has received support from multiple parties. China has included it in the key areas of "Healthy China 2030" and set up a special fund to support raw material innovation and technology research and development. The Yihai Kerry soy protein project and Feihe milk protein technology have received support from the National Science and Technology Support Program. Local governments use tax exemptions and industrial park construction to cultivate industrial clusters, Heilongjiang builds a dairy based industry belt with black soil resources, and Guangdong focuses on tropical plant extracts to form a complete industrial chain. Internationally, China, the United States, and Europe have strengthened coordination and docking of international standards, promoted mutual recognition of key raw material standards and efficacy testing methods, and cleared obstacles for cross-border trade and technological cooperation.

6. FUTURE TRENDS AND DEVELOPMENT STRATEGIES OF FUNCTIONAL FOODS

In the next five years, the functional food industry will form four major development trends around "precision, naturalization, scenarization, and sustainability". The 2024 Global Functional Food Innovation Report predicts that personalized nutrition will become the core track, and customized products based on genetic testing and lifestyle data will accelerate their landing. Feihe has launched a full lifecycle precision nutrition matrix and plans to launch DHA fortified formula for pregnant women and MLCT fat reduction products for obese populations; The demand for preventive health management continues to be released, and products focusing on intestinal health, metabolic regulation, and emotional management have become new growth poles. Euromonitor International monitoring shows that sales of digestive functional beverages increased by 34% year-on-year in 2024, confirming this trend. The integration of technology drives cross-border innovation in industries, the combination of food technology and digital technology, blockchain for full traceability of raw materials, AI algorithm optimization of product formula design, and the "AI IoT blockchain" framework proposed by the Chinese Academy of Agricultural Sciences team achieve 100% accuracy in sesame oil adulteration through Raman spectroscopy combined with 1D-CNN model, and use the immutable characteristics of blockchain to record the entire process data of raw materials [6]. Yihai Kerry's "Food Nutrition Digitalization Technology" has achieved precise control of product nutritional components at the microgram level; The process of cross disciplinary technology transfer is

accelerating, and pharmaceutical grade supercritical CO₂ extraction technology is used to prepare functional ingredients, increasing the purity of plant sterols and other substances to over 99%; The innovation of dosage forms is extending towards "convenience and snacking". In addition to gummies and functional tea drinks, new categories such as functional chocolates and freeze-dried nutritional snacks continue to emerge, adapting to the habits of young consumers. Green and sustainable development has become a new dimension of industrial development, with the promotion of a "circular economy" model on the raw material side. Feihe uses "livestock and poultry manure+corn stover" fermentation to produce organic fertilizer, improving the quality of raw materials while reducing environmental load; The production end widely adopts low-carbon processes, and Yihai Kerry Green Factory has utilized waste heat recovery and photovoltaic power supply transformation, resulting in a 20% reduction in energy consumption compared to the industry average; Promote biodegradable biobased materials on the packaging end to reduce plastic pollution. Innova's 2024 survey shows that 68% of Generation Z are willing to pay a 5% -10% premium for environmentally friendly functional foods. To address the issues of incomplete efficacy verification, inconsistent standards, and low trust in the industry, it is necessary to work together from three aspects: firstly, to build a collaborative innovation system of "industry university research and medical", relying on Jiangnan University, PLA General Hospital, and other institutions to establish efficacy evaluation platforms, such as the Chinese Nutrition Society's glycerol diester oil population intervention research project to strengthen scientific support; Secondly, we need to improve industry standards, unify national standards for raw material testing, efficacy claims, and labeling, and promote alignment with international standards; We need to strengthen consumer education, clarify the boundary between functional foods and drugs, and enhance industry trust through transparent promotion such as science popularization by the Chinese Nutrition Society and public efficacy data by enterprises.

7. CONCLUSION

The functional food industry is in a critical transition stage from scale expansion to quality upgrading, with a distinct development pattern formed by the steady growth of the global market and the rapid rise of the Chinese market. In 2024, the global functional food market will reach a volume of 108 trillion yuan, and industry statistics show that China has become the global core growth pole of this industry with a market size of 352.3 billion yuan. The achievements come from the synergistic empowerment of consumer demand upgrading, technological innovation breakthroughs, and policy system improvement. The current industry development is characterized by deepening market segmentation, technology penetration throughout the entire industry chain, precise stratification of consumer demand, and a sound regulatory system. However, it also faces bottlenecks such as insufficient efficacy verification, unresolved core technologies, and imbalanced regional development. Personalized nutrition, preventive health, technological integration, and green sustainability are the core development directions of the industry in the future. Personalized nutrition uses genetic testing and AI technology to achieve a transition from "group adaptation" to "individual customization". Preventive health focuses on emerging sub fields such as intestinal health and emotional management, while the integration of food technology and cross disciplinary technology promotes product form and efficacy upgrades. The concept of green production and sustainability reshapes the industrial value chain. The practice of companies such as Yihai Kerry and Feihe has proven that a path supported by technology, guided by demand, and with compliance as the bottom line is the key to enhancing corporate competitiveness.

Promoting high-quality industrial development requires multi-party collaboration. Enterprises should focus on core technology research and effectiveness verification, deepen industry university research collaboration, the government should improve the standard system and regulatory mechanism, increase support for raw material localization, and industry organizations should strengthen consumer education and corporate self-discipline. Under the guidance of the "Healthy China 2030" strategy, the

functional food industry will become a new growth pole of the food industry, providing support for the improvement of public health literacy and achieving the unity of industrial value and social value.

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