

# Building a Healthy Lactic Acid Bacteria Industry

Chenguang Zhu\*, Hongmei Niu, Zhixiong Wang

College of Health Management, Shanghai Jian Qiao University, Shanghai 201306, China

\*Corresponding author: Chenguang Zhu, [zhuchenguang@gench.edu.cn](mailto:zhuchenguang@gench.edu.cn)

**Copyright:** © 2025 Author(s). This is an open-access article distributed under the terms of the Creative Commons Attribution License (CC BY 4.0), permitting distribution and reproduction in any medium, provided the original work is cited.

**Abstract:** Lactic acid bacteria (LAB), as an important probiotic resource, play an irreplaceable role in maintaining human health, preventing diseases, and promoting the development of the food industry. With the deepening of the global “Big Health” concept and the increasing consumer demand for functional foods, the LAB industry is facing unprecedented opportunities for development, but also numerous challenges such as strain homogenization, an incomplete efficacy evaluation system, and confused market promotion. This paper aims to systematically review the current development status of China’s LAB industry and deeply analyze the key issues existing in areas such as strain resources, scientific research, product innovation, regulations and standards, and market education. By drawing on advanced international experience and considering China’s national conditions, this paper proposes strategic pathways for building a “healthy” and sustainable LAB industry from five dimensions: strengthening basic research and the development of proprietary strains, constructing a scientific and rigorous efficacy and safety evaluation system, promoting product diversification and technological innovation, improving the regulatory and standards environment, and enhancing consumer science education and market guidance. This research aims to provide theoretical reference and practical guidance for the high-quality development of China’s LAB industry.

**Keywords:** Lactic acid bacteria; Probiotics; Industry health; Functional evaluation; Regulations and standards; Sustainable development

**Online publication:** December 31, 2025

## 1. Introduction

Lactic acid bacteria (LAB) are a general term for a group of Gram-positive bacteria that can ferment carbohydrates to produce large amounts of lactic acid. They are widely found in the human gut, fermented foods, and the natural environment. Since the early 20th century, when Nobel laureate Élie Metchnikoff proposed the “yogurt longevity” theory, the probiotic functions of LAB have garnered increasing attention from the scientific and industrial communities. Substantial research confirms that specific LAB strains offer various health benefits, including regulating intestinal flora balance, enhancing immune function, promoting nutrient absorption, lowering cholesterol, and inhibiting pathogens<sup>[1,2]</sup>.

Against this backdrop, the global LAB industry continues to expand, with product forms diversifying from traditional yogurt and fermented milk beverages to probiotic powders, capsules, functional drinks, snacks, and more <sup>[3]</sup>. China, as one of the world's largest consumer markets, has experienced rapid development in its LAB industry over the past two decades <sup>[4]</sup>. However, this rapid expansion has also exposed a series of deep-seated problems, such as reliance on imported core strains, relatively weak basic research, exaggerated product efficacy claims, and imperfect industry standards <sup>[5,6]</sup>. These issues not only constrain the industry's innovation capability and core competitiveness but may also harm consumer rights and undermine the credibility and healthy development of the entire sector. Therefore, systematically examining the current state of the industry, clarifying development bottlenecks, and exploring a path towards sustainable and healthy development hold significant theoretical value and practical importance. This article aims to systematically identify the bottlenecks hindering the development of China's lactic acid bacteria industry and to establish a "five-in-one" healthy industry development pathway that encompasses all segments of the industrial chain.

## **2. Current status and challenges of China's LAB industry**

### **2.1. Market size and product landscape**

China's LAB market has become one of the most dynamic globally. Product types are mainly concentrated in fermented dairy products (e.g., yogurt, LAB beverages), probiotic dietary supplements (powders, capsules), and emerging probiotic application products (e.g., probiotic chocolate, candy, baked goods) <sup>[7]</sup>. Fermented dairy products dominate the market share. However, significant homogenization exists in the current market, with products from different brands being highly similar in terms of strain claims and functional positioning, lacking distinctive, differentiated products <sup>[8]</sup>.

### **2.2. Core strain resources and intellectual property dilemma**

China's commercial LAB industry relies heavily on core strains provided by a few international companies (e.g., Chr. Hansen, DuPont Danisco) <sup>[9]</sup>. These strains have undergone long-term, extensive scientific research and clinical validation, possess clear functionality and safety data, and are highly trusted by the market. In contrast, although China possesses abundant traditional fermented food resources (e.g., Paocai, Suancai, Qula) harboring numerous indigenous LAB strains with potential application value, the systematic exploration, identification, preservation, and industrial development of these resources remain insufficient <sup>[5,10]</sup>. This results in constraints on intellectual property rights for core strains, challenging the industry's autonomous development.

### **2.3. Disconnect between scientific research and efficacy evaluation**

Although the number of domestic research papers on LAB is increasing year by year, there is a tendency towards "emphasizing basic research over application" <sup>[11]</sup>. Much of the research remains in the preliminary stages of strain isolation and *in vitro* functional screening, while studies progressing to animal model validation, and particularly large-scale, well-designed human clinical trials, are relatively scarce <sup>[12]</sup>. This leads to many indigenous strains having "potential but no evidence," making it difficult to translate them into products with clear health claims. Furthermore, the efficacy evaluation system is not yet unified, lacking industry-recognized evaluation standards and methods, making it hard to compare results from different studies and leaving room for non-standardized market promotion <sup>[13]</sup>.

## 2.4. Regulations, standards, and regulatory environment

China has initially established a regulatory framework including the “List of Bacteria Species that Can Be Used in Food” and the “Regulations for the Application and Review of Health Foods Containing Probiotics” [14,15]. However, compared to developed regions like Europe and the United States, China’s regulatory system still has room for optimization. For instance, the strain list is updated relatively slowly, failing to promptly include new strains proven safe by science; the management of health claims for probiotic foods is relatively strict, with lengthy approval processes and high costs, somewhat inhibiting corporate innovation impetus [16]. Simultaneously, there are blind spots in market supervision, with some ordinary foods illegally advertising “therapeutic effects,” blurring the line between food and medicine and disrupting market order [17].

## 2.5. Consumer cognition and market education bias

Consumer awareness of LAB is generally high, but the depth of knowledge varies. Common misconceptions include: equating LAB with probiotics; believing all LAB products have the same efficacy; and overlooking critical factors such as strain specificity, viable count, and survival rate [18,19]. These cognitive biases stem partly from exaggerated or vague promotion by enterprises pursuing marketing effects, and also reflect a lack of popular science efforts among consumers.

# 3. Strategic pathways for building a healthy LAB industry

Addressing the aforementioned challenges requires systematic innovation and upgrading across all segments of the industrial chain to build a “healthy” LAB industry.

## 3.1. Strengthening basic research and building a proprietary strain resource bank

Systematic exploration of indigenous resources: The state should establish special funds to support research institutions in systematically collecting, isolating, and identifying LAB resources from traditional fermented foods, healthy populations, and specific regional environments in China, establishing a national-level LAB strain resource bank [10,20].

Deepening research on strain functional mechanisms: Encourage genomics, proteomics, and metabolomics research on excellent indigenous strains to elucidate the mechanisms of their probiotic effects at the molecular level, such as adhesion and colonization capabilities, production of immunomodulatory substances, and interaction with host cells [21,22].

Promoting deep industry-academia-research integration: Establish a technology innovation system led by enterprises, guided by the market, and combining industry, academia, and research. Encourage large dairy companies to establish joint R&D centers with universities and research institutes to collaboratively conduct full-chain research from strain screening to productization [5,23].

## 3.2. Constructing a scientific and rigorous efficacy and safety evaluation system

Establish standardized evaluation procedures: Led by industry associations, jointly develop standardized efficacy evaluation guidelines covering *in vitro*, *in vivo* (animal experiments), and human clinical trials with research institutions and leading enterprises, ensuring the scientificity, reliability, and comparability of research data [12,13].

Strengthening human clinical validation: focus support on large-scale, randomized, double-blind, placebo-controlled human clinical trials for promising indigenous strains, accumulating high-level evidence-based medical

evidence to provide solid support for product functional claims <sup>[2,12]</sup>.

Improving whole-chain safety assessment: Establish a full-process safety monitoring system from strain identification (excluding pathogenicity and antibiotic resistance risks), production, and processing to finished products, ensuring the absolute safety of marketed products <sup>[15,24]</sup>.

### **3.3. Promoting product diversification and technological innovation**

Breaking through formulation and technological bottlenecks: Vigorously develop technologies such as high-availability freeze-dried powders and microencapsulation to solve the survival challenges of LAB during processing, storage, and in the gastrointestinal environment. Develop new product formulations suitable for different populations (e.g., infants, the elderly, patients with specific diseases) and different application scenarios (e.g., snacks, catering) <sup>[25,26]</sup>.

Exploring “LAB+” cross-border integration: Promote research on the combination of LAB with traditional Chinese medicine, functional ingredients (e.g., dietary fiber, phytosterols), other prebiotics or probiotics to develop composite products with synergistic effects <sup>[27,28]</sup>.

Embracing the trend of personalized nutrition: Utilize microbiome detection technology to explore personalized LAB product customization services based on individual gut microbiota characteristics, which is an important direction for future industry upgrading <sup>[29,30]</sup>.

### **3.4. Improving the regulatory, standards, and supervision environment**

Dynamically updating the strain list: Establish a more flexible and scientific strain approval mechanism. For new strains with sufficient scientific evidence proving their safety and efficacy, they should be promptly included in the “List of Bacteria Species that Can Be Used in Food” <sup>[16,17]</sup>.

Refining health claim management: Learn from international experience and explore a tiered and classified health claim management system. Allow specific health function claims for those with sufficient scientific evidence; allow “structure/function” claims for those with slightly lower levels of evidence, but require clear labeling <sup>[16,31]</sup>.

Strengthening market supervision and industry self-discipline: Market regulatory authorities should increase efforts to crack down on false and exaggerated advertising. Simultaneously, fully leverage the role of industry associations to develop self-regulatory conventions and guide enterprises to operate with integrity, jointly maintaining the industry’s reputation <sup>[15,17]</sup>.

### **3.5. Strengthening science communication and consumer education**

Disseminating scientific and accurate information: Government agencies, academic societies, and leading enterprises should jointly utilize various channels such as new media and science popularization lectures to educate the public on the basic knowledge of LAB and probiotics, emphasizing core concepts like “strain specificity,” “sufficient quantity,” and “long-term consumption” <sup>[1,19,32]</sup>.

Standardizing enterprise promotion practices: Require enterprises to clearly label the strain designation, viable count, and survival rate within the shelf life on product promotions, guiding consumers to learn to read product labels and make informed choices <sup>[18,33]</sup>.

Cultivating professionals: Establish relevant professional courses in universities to cultivate interdisciplinary talents with knowledge in microbiology, nutrition, food science, and marketing, reserving intellectual resources for

the sustainable development of the industry <sup>[5,34]</sup>.

#### 4. Conclusion and prospects

Building a “healthy” LAB industry is a systematic project involving multiple aspects such as scientific research, production, regulation, and consumption. It not only means the expansion of industrial scale and the enhancement of economic benefits but, more crucially, involves constructing an industrial ecosystem based on solid scientific research, guaranteed by rigorous regulations and standards, guided by genuine consumer value, and driven by sustainable innovation.

To achieve a robust and competitive LAB industry in China, a structured roadmap comprising three sequential phases—resource construction, technological breakthrough, and standardization leadership—is proposed, with clearly defined milestones and collaborative roles for government, industry, and research institutions. The resource construction focuses on systematically cataloging and preserving native LAB strains. Research institutions should lead the establishment of comprehensive, high-quality germplasm resource banks, utilizing large-scale genomic sequencing to map biodiversity and identify potential high-value strains <sup>[35,36]</sup>. Concurrently, government agencies must designate microbial resources as a strategic national asset, providing sustained funding and policy support for bioprospecting initiatives and the infrastructure for long-term preservation. The technological breakthrough aims to overcome the critical bottlenecks in industrial-scale cultivation, stabilization, and application. Enterprises, in close collaboration with academic partners, need to drive innovation in core technologies such as high-density fermentation, cryoprotection, and metabolic engineering to enhance bacterial viability and functionality in final products <sup>[37,38]</sup>. This phase requires a new industrial paradigm of “Innovation Execution,” where extreme cost and performance targets are embedded across the R&D and manufacturing value chain to accelerate commercialization. Finally, the standardization leadership is crucial for shaping the global landscape. The government’s role evolves to facilitating the establishment of a sophisticated regulatory and safety evaluation framework for probiotics, including evidence-based health claim verification and internationally aligned quality standards. Meanwhile, companies and research institutes must collaborate to generate robust clinical evidence for domestic strains and pioneer next-generation applications, such as personalized probiotic solutions, thereby transitioning China from a follower to a leader in setting global benchmarks for the LAB industry <sup>[39]</sup>.

Looking ahead, China’s LAB industry is full of opportunities and potential. With the deepening of the “Healthy China 2030” strategy and the continuous awakening of national health awareness, the demand for high-quality, personalized LAB products will continue to grow. We can expect to see:

- (1) A number of Chinese indigenous probiotic star strains with proprietary intellectual property rights and international influence emerge, breaking the monopoly of foreign companies <sup>[10,20]</sup>.
- (2) Personalized nutrition solutions based on big data and artificial intelligence will gradually become practical, with LAB products becoming an important part of precise nutritional interventions <sup>[29,30]</sup>.
- (3) The internationalization of the industry will further increase. China will not only be a huge consumer market but will also become an important exporter of global LAB technology and products <sup>[4,40]</sup>.

Achieving this grand vision requires the joint efforts of the government, industry, academia, and consumers, collaborating and innovating persistently. Only in this way can China’s LAB industry truly move towards health, maturity, and strength, making greater contributions to national health, well-being, and socio-economic development.

## Disclosure statement

The authors declare no conflict of interest.

## References

- [1] Hill C, Guarner F, Reid G, et al., 2014. The International Scientific Association for Probiotics and Prebiotics Consensus Statement on the Scope and Appropriate Use of the Term Probiotic. *Nat Rev Gastroenterol Hepatol*, 11(8): 506–514.
- [2] Sanders ME, Merenstein DJ, Reid G, et al., 2019, Probiotics and Prebiotics in Intestinal Health and Disease: From Biology to the Clinic. *Nat Rev Gastroenterol Hepatol*, 16(10): 605–616.
- [3] Marco ML, Sanders ME, Gänzle M, et al., 2021, The International Scientific Association for Probiotics and Prebiotics (ISAPP) Consensus Statement on Fermented Foods. *Nat Rev Gastroenterol Hepatol*, 18(3): 196–208.
- [4] Liu J, Li XJ, 2022, Prediction of Development Trends in China’s Lactic Acid Bacteria Market. *Food Res Dev*, 43(3): 211–215.
- [5] He GQ, Ruan H, Li PL, 2017, Discussion on Scientific and Technological Innovation in the Development of China’s Lactic Acid Bacteria Industry. *Food Sci*, 38(15): 292–297.
- [6] Gu RX, Xie YK, Chen DW, 2018, Scientific Issues and Countermeasures in the Development of the Probiotic Industry. *J Dairy Sci Technol*, 41(1): 37–41.
- [7] Wang YY, Liu J, Li XJ, 2021, Analysis of the Current Situation and Development Trend of China’s Lactic Acid Bacteria Industry. *China Dairy*, (5): 68–72.
- [8] Guo ST, Luo TH, 2021, Strategic Thinking on the Development of the Functional Food Industry under the Background of Healthy China. *J Chin Institute Food Sci Technol*, 21(5): 1–8.
- [9] Zhang HP, Sun ZH, 2020, Research and Industrial Development of Probiotics in China. *J Chin Institute Food Sci Technol*, 20(10): 1–10.
- [10] Chen W, Zhai QX, Tian FW, 2018, Mining and Utilization of Lactic Acid Bacteria Resources. *J Food Sci Biotechnol*, 37(1): 1–8.
- [11] Gu RX, Chen W, Zhang HP, 2019, Probiotic Scientific Consensus. *J Chin Institute Food Sci Technol*, 19(7): 1–9.
- [12] Sun ZH, Zhang HP, 2017, Establishment and Application of Probiotic Function Evaluation System. *J Chin Institute Food Sci Technol*, 17(1): 1–9.
- [13] Yuan J, Li N, 2018, Challenges and Prospects of Clinical Research on Probiotics. *Chin J Clin Nutr*, 26(4): 193–197.
- [14] National Health Commission of the People’s Republic of China, 2010, List of Bacteria Species that Can Be Used in Food, National Standard of the People’s Republic of China, viewed October 25, 2025, <https://www.nhc.gov.cn/wjw/gfxwj/201004/af77e760cf2b4989a40dc8641d3cf263.shtml>
- [15] State Administration for Market Regulation, 2005, Regulations for the Application and Review of Health Foods Containing Probiotics (Trial), viewed October 27, 2025, [https://www.cfe-samr.org.cn/zcfg/bjbsp\\_134/gsgg/zc/202207/t20220729\\_4388.html](https://www.cfe-samr.org.cn/zcfg/bjbsp_134/gsgg/zc/202207/t20220729_4388.html)
- [16] Luo TH, Guo ST, 2022, Comparative Study on Regulations and Standards for Probiotics at Home and Abroad. *Sci Technol Food Ind*, 43(1): 1–9.
- [17] Li XJ, Liu J, Wang YY, 2020, Research on Consumers’ Cognition and Purchasing Behavior of Probiotic Products. *Food Nutr Chin*, 26(12): 49–52.
- [18] Liu ZM, Wang JG, Fu XL, 2019, Research Progress on the Mechanism of Probiotics in Intestinal Health. *Food Sci*, 40(11): 331–337.

- [19] Zhai QX, Tian FW, Chen W, 2019, Research Progress on the Interaction Between Probiotics and Gut Microbiota. *Chin J Biotechnol*, 35(8): 1393–1404.
- [20] Wang J, Sun TS, Zhang HP, 2016, Construction and Sharing of Lactic Acid Bacteria Resource Bank. *Microbiology China*, 43(10): 2285–2292.
- [21] Shen QW, Li PL, 2017, Research Progress in Lactic Acid Bacteria Genomics and Its Application in Industry. *Food Ferment Ind*, 43(4): 253–259.
- [22] Yuan J, Li N, 2020, The Role of Probiotics in Immune Regulation and Progress in Clinical Research. *Int J Digest Dis*, 40(4): 217–220.
- [23] Zhao JX, Tian FW, Chen W, 2020, Research Progress on High-Density Culture and High-Activity Preparation Technology of Lactic Acid Bacteria. *Food Ferment Ind*, 46(8): 274–280.
- [24] Li PL, Shen QW, He GQ, 2015, Research Progress on Safety Evaluation of Lactic Acid Bacteria. *J Chin Institute Food Sci Technol*, 15(10): 1–8.
- [25] Han X, Zhang LW, Yi HX, 2018, Research Progress on the Application of Microencapsulation Technology in Probiotic Products. *Sci Technol Food Ind*, 39(16): 309–314.
- [26] Yi HX, Zhang LW, 2018, Factors Affecting the Survival Rate of Probiotics and Research Progress in Protection Technologies. *Modern Food Sci Technol*, 34(1): 1–8.
- [27] Xie YK, Gu RX, 2019, Research Progress on the Synergistic Effects of Probiotics and Prebiotics. *Sci Technol Food Ind*, 40(14): 317–322.
- [28] Fu XL, Liu ZM, 2019, Research Progress on Metabolites of Lactic Acid Bacteria and Their Functions. *China Dairy Ind*, 47(4): 33–37.
- [29] Ruan H, He GQ, 2021, Application Prospects of Lactic Acid Bacteria in Personalized Nutrition. *Food Sci*, 42(15): 355–361.
- [30] Tian FW, Chen W, 2018, Diversity and Function of Lactic Acid Bacteria in Traditional Fermented Foods. *China Brewing*, 37(2): 1–6.
- [31] Probiotics Branch of the Chinese Society for Food Science and Technology, 2020, Probiotic Scientific Consensus. *J Chin Institute Food Sci Technol*, 20(5): 303–307.
- [32] Słabuszewska-Jóźwiak A, Szymański JK, Ciebiera M, et al., 2020, Pediatrics Consequences of Caesarean Section: A Systematic Review and Meta-Analysis. *Int J Environ Res Public Health*, 17(21): 8031.
- [33] Guarner F, Sanders ME, Szajewska H, et al., 2024, World Gastroenterology Organisation Global Guidelines: Probiotics and Prebiotics. *J Clin Gastroenterol*, 58(6): 533–553.
- [34] Cai Y, 2006, Consideration of China Lactobacillus Industry Development Strategy. *China Food Ind*, 6: 9–10.
- [35] Klaenhammer TR, 2019, Get Cultured: Eat Bacteria. *Annu Rev Food Sci Technol*, 10: 1–20.
- [36] Gao H, Li X, Chen X, et al., 2022, The Functional Roles of *Lactobacillus acidophilus* in Different Physiological and Pathological Processes. *J Microbiol Biotechnol*, 32(10): 1226–1233.
- [37] Brettel M, Heinemann F, Engelen A, et al., 2011, Cross-Functional Integration of R&D, Marketing, and Manufacturing in Radical and Incremental Product Innovations and Its Effects on Project Effectiveness and Efficiency. *J Prod Innov Manage*, 28: 251–269.
- [38] Wang B, Li Y, Freiheit T, 2022, Towards Intelligent Welding Systems from a HCPS Perspective: A Technology Framework and Implementation Roadmap. *J Manuf Syst*, 65: 244–259.
- [39] Elijah O, Rahman TA, Orikumhi I, et al., 2018, An Overview of Internet of Things (IoT) and Data Analytics in Agriculture: Benefits and Challenges. *IEEE Internet Things J*, 5(5): 3758–3773.

[40] Zhang HP, Sun ZH, 2020, Research and Industrial Development of Probiotics in China. Journal of Chin Institute Food Sci Technol, 20(10): 1–10.

**Publisher's note**

Bio-Byword Scientific Publishing remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.