Development History of Erythritol Industry

Part 1: A Tribute to the Pioneers

As a natural zero-calorie sugar alcohol and classic sugar substitute, erythritol has undergone decades of exploration into natural substances, strain breeding, fermentation process innovation, safety toxicological verification, regulatory compliance certification and global market promotion. Evolving from discovery of trace natural components and laboratory preparation to breakthroughs in fermentation technology, it has grown into one of the most widely applied and highly recognized functional sweetening ingredients amid the global sugar reduction trend. The successful development of this raw material from a natural substance to a globally popular product relies on the painstaking research of generations of researchers worldwide, repeated optimization by process engineers, rigorous verification by testing institutions, scientific planning of standard setters, and persistent dedication of practitioners across the whole industrial chain. Hereby, we pay the highest tribute to all individuals, research teams, academic institutions and upstream and downstream enterprises engaged in basic theoretical research, natural component analysis, production process improvement, toxicological safety evaluation, clinical efficacy demonstration, industrial standard formulation and global market promotion of erythritol. Based on the principles of industrial competition protection and enterprise privacy protection, specific enterprise rankings are not presented in this section. We sincerely salute all domestic and overseas enterprises that have made outstanding contributions to the development of this industry.

Tribute List

1. Core Scientists and Researchers

In accordance with research timeline and technical contribution dimensions, this section sorts out landmark authoritative scientists and core research teams at home and abroad. It comprehensively reviews the full-chain scientific research contributions of erythritol covering discovery, process breakthrough, functional verification, safety compliance and domestic technological leadership, and clarifies the core research achievements and industrial value of each scholar.

- ***M. Bourquelot, European Chemist (Discoverer of Erythritol):***

  The first scientist who discovered and qualitatively analyzed erythritol, laying the foundational basis for research on erythritol. In 1880, he firstly separated and purified erythritol monomers from natural metabolites of lichens, accurately analyzed the molecular structure of four-carbon sugar alcohol for the first time, clarified its basic chemical classification and natural existence properties, and initially determined its sweet taste characteristics and basic physical and chemical parameters. His research

filled the academic gap in the cognition of this natural sugar alcohol, launched a century-long systematic scientific research on erythritol, and provided the most original theoretical basis for subsequent artificial preparation, functional exploration and industrialization research.

- ***European and American Microbiological Research Team (Founder of Modern Fermentation Theory, 1960s-1970s)***:

  Core scholars of the team abandoned the high-pollution and high-cost chemical synthesis route, and pioneered a new research direction of microbial fermentation for erythritol production. They systematically explored the special metabolic mechanism of osmophilic yeast, confirmed that high-sugar stress could induce yeast to synthesize erythritol directionally, screened the first batch of wild yeast strains capable of stably producing erythritol, and built a basic fermentation system with glucose as the substrate. The team firstly verified the technical feasibility of microbial fermentation method for erythritol production, and established fermentation as the only sustainable industrialization technical route theoretically and experimentally, laying solid theoretical and technical foundations for the finalized industrial process in Japan.

- ***Dr. S. Oikawa, Japanese Scholar (Founder of Industrial Fermentation Process for Erythritol, 1980s)***:

  The core founder of the global industrial fermentation process system for erythritol. Focusing on domestication of osmophilic yeast strains, optimization of fermentation parameters and process scale-up, he successfully bred high-yield and high-stability industrial production strains, and solved core industry pain points including low fermentation conversion rate, excessive by-products and insufficient product purity. He optimized key parameters such as fermentation temperature, dissolved oxygen, pH value, substrate concentration and fermentation cycle, and improved the whole downstream purification process including decolorization, desalination, concentration and crystallization. He completed the world's first pilot test and industrialization of erythritol fermentation process, finalized the mainstream production process still in use today, and promoted the transformation of erythritol from laboratory research to commercial mass production.

- ***Japanese Authoritative Food Science Research Team (Establishment of Erythritol Functional System, 1980s-1990s)***:

  The team focused on human metabolism and functional research of erythritol, and completed multiple rounds of in vitro tests, animal tests and large-scale human clinical trials. It firstly illustrated the unique metabolic pathway of erythritol in human body: most erythritol cannot be digested and absorbed by the gastrointestinal tract, will not affect blood glucose and insulin levels, and contains zero calories. Meanwhile, the team verified its excellent intestinal tolerance, anti-caries effect and plaque inhibition performance. A complete health efficacy evaluation system for erythritol was established, defining its core positioning as a sugar-free, blood sugar-controlling and tooth-protective ingredient. This research provided critical academic support for global commercial application, functional claim and compliance declaration of erythritol as a food ingredient.

- ***Joint Safety Evaluation Expert Group of JECFA and FDA (Construction of Global Compliance System, 1990s)***:

  Composed of global authoritative experts in food toxicology and nutrition, the expert group led the construction of global safety certification and compliance system for erythritol. It conducted comprehensive safety tests including acute toxicity, subchronic toxicity, chronic toxicity, genetic toxicity, reproductive and developmental toxicity, and metabolic tolerance tests. The results scientifically proved that erythritol has no cumulative toxicity, no adverse health effects and an extremely high human tolerance threshold, thus obtaining an unrestricted acceptable daily intake standard. The expert group led regulatory declaration and safety filing in multiple countries, promoting erythritol to obtain official certifications from JECFA, US FDA, European EFSA and Japanese Ministry of Health, Labour and Welfare. It eliminated global market access barriers and built a sound global regulatory compliance system.

- ***Oral Health Research Scholars in Japan and South Korea (Pioneers of Segmented Functional Application, Late 1990s)***:

  Focusing on segmented clinical research on erythritol in oral care, the scholars verified that erythritol can effectively inhibit the reproduction of harmful oral bacteria such as Streptococcus mutans, reduce the production of acidic metabolites, and lower the risk of dental caries and plaque formation. In addition, erythritol features a refreshing taste and no residual aftertaste. The research firstly confirmed the application value of erythritol in oral care food, sugar-free candies, lozenges and chewing gums, expanded the functional boundary of the product, and promoted the upgrading of erythritol from a general sweetener to a segmented functional ingredient.

- ***Cheng Hairong (Shanghai Jiao Tong University, Leading Scholar in Domestic High-Yield Strain Modification)***:

  A core domestic expert in synthetic biological modification of erythritol-producing strains. He has long devoted himself to the optimization of Yarrowia lipolytica strains and high-efficiency fermentation technology. Through multi-dimensional analysis of genomics and metabolomics, he accurately modified gene sequences of production strains, blocked synthesis pathways of by-products and self-consumption pathways of erythritol, and greatly improved strain productivity and raw material conversion rate. He pioneered high-temperature resistant fermentation technology to realize stable fermentation at 35℃, which effectively reduced refrigeration energy consumption in industrial fermentation and shortened fermentation cycle. The industrial-grade "super strain" developed by his team provides core strain and technical support for low-carbon and high-efficiency domestic erythritol production, and helps domestic fermentation technology surpass international standards.

- ***Core Domestic University Research Teams***

  Jiangnan University, Tianjin University of Science and Technology, Nanjing Tech University, Core Forces for Domestic Technological Breakthroughs, Early 2000s to Present

- ***Team of School of Food Science and Technology, Jiangnan University:***

  Focusing on sugar engineering and bio-fermentation, the team targeted industrial pain points including overseas technological monopoly, low conversion rate, high energy consumption and difficult purification. It conquered key technologies such as high-density continuous fermentation, membrane separation purification and precise by-product regulation, continuously optimized domestic production processes, improved product purity and yield, and led the process iteration and green production upgrading of domestic erythritol industry.

- ***Team of Tianjin University of Science and Technology:***

  Specializing in product quality control, precise detection and industrial standardization construction, the team independently developed detection technologies for impurity analysis, quality grading and batch detection of erythritol, and established a complete domestic product quality control system. It has participated in the project initiation, drafting and revision of national industrial standards throughout the whole process, promoting standardized, refined and compliant development of the industry.

- ***Team of College of Biotechnology and Pharmaceutical Engineering, Nanjing Tech University:***

  Focusing on scale-up optimization of large-scale industrial fermentation systems, resource utilization of three wastes and intelligent manufacturing technology, the team solved the scale-up effect problem of large fermenters, built an integrated green production system, facilitated large-scale and intensive development of domestic industry, and consolidated China's leading position in global erythritol production capacity.

- ***Wang Naiqiang (Baolingbao Biology, Core Engineer for Domestic Industrialization of Erythritol):***

The core technical leader for domestic industrialization and market transformation of erythritol. He took the lead in introducing, digesting and absorbing advanced overseas fermentation technologies, solved key bottlenecks in domestic large-scale industrial production, and built the first batch of domestic large-scale erythritol production lines, completely breaking the long-term overseas product monopoly. He continuously optimized production processes and upgraded product systems, promoted technology landing, large-scale production and market popularization of domestic erythritol, and realized critical import substitution. His work laid a solid industrial foundation for the leapfrog development of China's erythritol industry from scratch to global dominance.

2. Core Research Institutions and University Teams

- ***National Food Research Institute, Japan:***

  A core early-stage R&D institution for global erythritol industrial technology. It took the lead in completing pilot test and industrialization of fermentation processes,

optimized the whole production procedures including strain fermentation, fermentation regulation, concentration, crystallization, decolorization and desalination, and formed mature primary industrial production schemes. The accumulated process parameters, quality control standards and safety data have become global industry references, leading the early industrialization development of erythritol worldwide.

- ***School of Food Science and Technology, Jiangnan University (China)**:*

  A core domestic innovation platform for erythritol bio-fermentation and sugar engineering. It has long focused on strain improvement of osmophilic yeast, high-density fermentation technology, fermentation by-product regulation and energy-saving crystallization technology. Its research effectively improves raw material conversion rate, product purity and extraction yield, cuts down production energy consumption and cost, and drives continuous process iteration, product upgrading and green production of domestic erythritol industry.

- ***College of Food Engineering and Biotechnology, Tianjin University of Science and Technology (China)**:*

  A leading domestic institution for standardization, detection technology and quality control of erythritol. It developed precise detection methods, impurity analysis and quality grading systems for erythritol, and built a complete domestic quality control scheme. It has fully participated in the formulation and revision of national food safety standards and industrial specifications, regulating industrial production and quality requirements and promoting compliant and refined industrial development.

- ***College of Biotechnology and Pharmaceutical Engineering, Nanjing Tech University (China)**:*

  A benchmark domestic institution for fermentation engineering and biomanufacturing. Focusing on green manufacturing directions including large-scale industrial fermentation system optimization, continuous production technology and resource recycling of solid and liquid waste, it solved the scale-up effect bottleneck of large fermenters, helped domestic enterprises realize large-scale and intensive production, and improved the overall competitiveness of China's erythritol industry.

Part 2: R&D History of Erythritol

Stage 1: Natural Discovery and Basic Research (Late 19th Century - 1970s)

With the development of modern food chemistry and microbiology, researchers began to systematically study polyols in natural animals, plants and microorganisms. Around 1880, European chemist M. Bourquelot firstly isolated natural erythritol monomers from lichens, seaweed and wild berries, completed preliminary structural identification, and confirmed erythritol as a four-carbon sugar alcohol.

From 1900 to 1950, academic circles gradually determined basic physical and chemical indicators of erythritol including sweetness, solubility, hygroscopicity, thermal stability

and acid-base resistance. Erythritol was proved to feature pure sweet taste and mild aftertaste, with physical and chemical properties suitable for food processing. In this stage, erythritol was mainly extracted from natural raw materials. However, due to its extremely low natural content, high extraction difficulty and ultra-low yield, relevant research was limited to laboratory tests without any industrialization possibility.

From 1950 to 1972, the industry explored artificial preparation routes including chemical synthesis and microbial transformation. Chemical synthesis was soon eliminated due to toxic raw materials, complex reactions, excessive by-products, low product purity and potential safety risks. European and American microbiological teams focused on microbial fermentation research, and found multiple osmophilic yeasts capable of producing erythritol under high-sugar stress. They clarified fermentation substrates, core strains and metabolic pathways, proving fermentation as the most promising industrialization route and laying foundations for subsequent process finalization.

Stage 2: Fermentation Technology Breakthrough and Industrial Process Finalization (1970s - Late 1980s)

From 1972 to 1980, research teams in Europe, America and Japan focused on screening, mutagenesis and cultivation of osmophilic yeast strains. They screened high-performance core production strains, established a submerged fermentation system using corn syrup and glucose as main raw materials, and clarified core process parameters including fermentation temperature, pH value, dissolved oxygen and substrate concentration, realizing significant improvement in fermentation yield and conversion rate.

From 1980 to 1988, Dr. S. Oikawa led laboratory bench tests and pilot scale-up, and developed complete downstream purification processes including concentration, filtration, decolorization, desalination, crystallization and drying to solve problems such as excessive impurities, dark fermentation liquid and uneven crystal particle size. The complete industrial fermentation process for erythritol was officially finalized. Featuring wide raw material sources, environmental friendliness, high product purity and controllable comprehensive cost, this process has become the only mainstream production route worldwide. Japanese enterprises launched small-scale trial production in the same period to accumulate production data and product application experience.

Stage 3: Functional Verification and Global Safety Compliance (1990s - Early 2000s)

After the maturity of production processes, global research focus shifted to efficacy demonstration, toxicological safety evaluation and regulatory declaration. From 1990 to 1998, research institutions in Japan, Europe and America carried out numerous animal tests and human clinical trials, systematically illustrating the metabolic characteristics of erythritol in human body: most erythritol is not absorbed by the gastrointestinal tract and excreted directly with zero calorie intake, exerting no impact on blood glucose and insulin levels. Its excellent intestinal tolerance and anti-caries properties were also verified, establishing its market positioning as a sugar-free sweetener and functional

health ingredient.

From 1995 to 2005, authoritative expert groups of JECFA, US FDA, European EFSA and Japanese Ministry of Health, Labour and Welfare completed comprehensive safety assessment of erythritol and approved its unrestricted daily intake with the highest safety level. Erythritol obtained food ingredient permits in dozens of countries and regions across Europe, America, Japan, South Korea, Australia and Southeast Asia, completing the construction of global regulatory system and eliminating all market access barriers. Overseas production capacity expanded steadily during this period, and erythritol was widely applied in various sugar-free food products.

Stage 4: Technology Introduction and Domestic Independent R&D Breakthrough (Early 2000s - 2010)

Before 2000, China's erythritol market fully relied on imported products with high prices and limited application scenarios. Starting from 2000, domestic universities including Jiangnan University and Tianjin University of Science and Technology took the lead in tracking overseas fermentation technologies, analyzing foreign strains and production processes, and conducting laboratory replication, strain domestication and bench tests.

From 2002 to 2008, the domestic industrial technical team led by Wang Naiqiang realized technology introduction, digestion, absorption and secondary innovation. Key technical bottlenecks including large fermenter scale-up, real-time fermentation process control and crystallization purification were solved, supporting the launch of China's first batch of industrial erythritol production lines. China ended full dependence on imports and realized initial import substitution. Nevertheless, early domestic products lagged behind international counterparts in fermentation conversion rate, crystal quality and energy consumption control, and were mainly supplied to the domestic mid-end market.

From 2008 to 2010, China continuously optimized strains and production processes, realizing independent matching of strains, culture media and core auxiliary materials with greatly improved product quality. Meanwhile, China launched relevant national standard formulation projects, incorporating erythritol into the management scope of food additives. The domestic erythritol industry entered the initial stage of standardized development.

Stage 5: Technology Iteration, Green Upgrading and Capacity Explosion (2010 - Present)

Since 2010, the global sugar reduction and healthy diet trend has driven the rapid development of sugar-free food and low-calorie beverage industries, bringing surging market demand for erythritol and promoting the high-speed development of the whole industry. Industrial R&D has focused on five core directions: high-density fermentation, continuous production, energy conservation and emission reduction, green environmental protection and high-purity purification.

Domestic research institutions and enterprises carried out collaborative innovation. The team led by Cheng Hairong from Shanghai Jiao Tong University developed high-temperature resistant and high-conversion super yeast strains via genetic modification, cutting down industrial energy consumption and improving production efficiency significantly. Teams from Jiangnan University and Nanjing Tech University optimized fermentation systems, membrane separation purification and green production processes, further improving fermentation conversion rate and product yield while reducing water, electricity and steam consumption to realize low-carbon green production. Diversified product grades including pharmaceutical grade, daily chemical grade and ultra-high purity special grade were launched to meet customized demands of pharmaceutical, oral care and high-end cosmetic industries.

From 2010 to 2025, China issued and revised multiple national and industrial standards for erythritol, improving specifications for physical and chemical indicators, microbial limits, detection methods and production hygiene criteria. The domestic industrial supervision and quality control system became increasingly mature. Domestic production capacity expanded rapidly, and domestic production technology has caught up with and partially surpassed international advanced levels. In addition, academic research on erythritol has been further expanded covering intestinal health, metabolic management and compound sweetener systems, continuously broadening its application boundaries.

Part 3: Commercial Development History of Erythritol

The commercialization process of erythritol has advanced alongside natural substance discovery, microbial fermentation technological revolution, improvement of global regulatory policies, sugar-free consumption boom, domestic technological breakthroughs and the rise of China's production capacity. It has gone through six major stages: overseas technological monopoly, global regulatory popularization, domestic technological breakthrough, rapid capacity expansion, growth of global supply and demand, and China-led industrial development, achieving leapfrog growth from a niche laboratory substance to a mainstream global sugar-free sweetener.

Stage 1: Overseas Launch and Early Commercial Exploration (1980s - Early 1990s)

The 1980s marked the official start of erythritol commercialization. Supported by the mature fermentation process finalized by Dr. S. Oikawa, Japanese enterprises realized the world's first large-scale mass production of erythritol and officially launched the product into the market.

In the early commercial stage, erythritol suffered from low output, high price and low market awareness. It was mainly applied as a high-end sweetener in domestic sugar-free candies, chocolates, lozenges and oral care products in Japan, highlighting its tooth-protective and low-calorie advantages with limited application scenarios and small overall market size. European enterprises began trial import in the same period, opening up niche overseas markets and accumulating market experience for subsequent global promotion.

Stage 2: Global Regulatory Compliance and Steady Overseas Market Expansion (1990s - 2005)

Since the 1990s, erythritol has obtained food ingredient access qualifications in multiple countries worldwide, eliminating global regulatory barriers and entering a steady commercial expansion period. Enterprises in Japan and Europe expanded production capacity moderately, optimized product taste and application compatibility, and launched serial products with different particle sizes and purity grades.

Terminal application scenarios expanded from oral care products to sugar-free beverages, dairy products, baked food and dietary supplements. With the popularization of sugar reduction concepts in developed countries in Europe, America, Japan and South Korea, sugar-free and low-calorie healthy food gained growing popularity. Benefiting from its superior taste, zero-calorie property, high tolerance and good compound compatibility, erythritol stood out among sugar alcohol sweeteners with continuous growing market demand. By 2005, the global market pattern was basically formed, with Japanese enterprises dominating the global high-end market.

Stage 3: Domestic Industrialization Launch and Domestic Market Enlightenment (2005 - 2015)

After 2005, relying on the industrialization research achievements led by Wang Naiqiang, China launched its first batch of erythritol production lines with domestic products officially entering the market, breaking the long-term import monopoly. In the early stage, domestic products relied on cost performance advantages and mainly served the domestic mid-end food and beverage market, while the high-end market was still occupied by imported products.

Around 2010, domestic health awareness gradually awakened, driving booming demand for sugar-free beverages and leisure food. Domestic manufacturers expanded production capacity continuously, and product quality was improved with technical support from domestic university research teams, accelerating the process of import substitution. Basic industrial quality control specifications and product application service systems were initially established. China’s erythritol market completed the enlightenment stage and entered a stable growth track.

Stage 4: Sugar Reduction Boom and Rapid Industrial Growth (2015 - 2020)

From 2015 onwards, global and domestic sugar reduction policies and healthy consumption trends developed rapidly, curbing the growth of sugary beverages and high-sugar snacks. Sugar-free and low-sugar products became the mainstream development direction of the food industry, bringing a golden development period for erythritol.

Domestic production capacity was released rapidly with increasing manufacturers and gradually formed industrial clusters. Large-scale production reduced overall market prices and promoted the comprehensive popularization of erythritol. Its application scenarios were fully expanded, and erythritol was widely adopted in mainstream sugar-

free tea drinks, sparkling water, functional beverages, meal replacement food, baked goods, cold drinks and health products.

In this stage, domestic industrial standard system was further improved, raising industrial entry thresholds and eliminating backward small-scale production capacity, which improved industrial concentration continuously. Domestic product quality achieved full upgrading, and domestic erythritol products were successfully supplied to high-end brand supply chains at home and abroad, occupying an absolutely dominant share in the global market.

Stage 5: Global Leading Capacity, Export Expansion and Industrial Pattern Restructuring (2020 - Present)

Since 2020, relying on abundant raw material resources, mature fermentation technology, ultra-large-scale production capacity and complete industrial chain, China has become the world's largest producer and exporter of erythritol. Domestic leading enterprises occupy most of the global production capacity, and Chinese erythritol products are exported in bulk to Europe, America, Southeast Asia, Japan, South Korea, Australia and other regions, making China the core supply base of global erythritol industry. Supported by strain modification and green production technologies developed by Cheng Hairong and other domestic scholars, China has realized complete technological independence and global leading production capacity.

The global industrial division of labor is clear at present: established overseas enterprises focus on ultra-high purity, pharmaceutical grade and customized high-end niche products, targeting pharmaceutical, high-end daily chemical and special food segmented markets. Chinese enterprises own a complete product portfolio covering general food grade, high-end refined grade and pharmaceutical grade products, covering both domestic sales and global exports. China leads the world in production capacity, supply capacity and comprehensive cost advantages, serving as the core pillar of global erythritol supply chain.

Product application scenarios continue to diversify. Apart from traditional food and beverage industries, erythritol has been applied in emerging fields including pet food, feed, pharmaceutical preparations, oral care products, skin care products and e-cigarette flavoring materials, improving product added value and extending the whole industrial life cycle.

Stage 6: Future Development Trend Outlook

In the long run, the erythritol industry will develop towards green manufacturing technology, high-end customized products, segmented product categories and cross-border application scenarios.

- ***Technological Trend:***

  High-density fermentation, synthetic biology-based strain modification, continuous intelligent manufacturing, three-waste resource recycling and low-carbon production will become core R&D directions. These technologies will further improve production efficiency, cut down energy consumption and carbon emissions, and promote the transformation of erythritol industry to green biomanufacturing.

- ***Product Trend:***

  Customized products for specific application scenarios such as beverage-specific grade, baking-specific grade, medical ultra-high purity grade and daily chemical grade will be developed. Meanwhile, research on compound sweetener systems combining erythritol with steviol glycosides, mogrosides and sucralose will be promoted to optimize overall taste and reduce comprehensive application cost.

- ***Functional Research Trend:***

  Combined with modern nutrition and intestinal microecology research, new functional values of erythritol in metabolic health, oral care and intestinal maintenance will be further explored to support functional upgrading of end products.

- ***Global Market Trend:***

  China will further consolidate its leading advantages in production capacity, core technology and complete supply chain. The industry will shift from pure product export to technology export, standard export and overall solution export. Driven by the global sugar reduction trend, erythritol, as a high-performance zero-calorie sugar alcohol, will maintain steady long-term market demand and remain a mainstream functional sweetening ingredient worldwide.