Development History of the Stevia Industry

Part One: A Tribute to the Pioneers

As a high-potency sweetener derived from natural plants, stevia has undergone over a century of exploratory research and more than seven decades of industrial development, spanning from the discovery of wild plants in South America, isolation and identification of active ingredients, analysis of chemical structures, toxicological safety evaluation, to the formation of a complete industrial system covering extraction, purification, grading and compound application. Boasting characteristics such as high sweetness, low calorie, non-glycemic and natural safety, it has become a core functional sweetening ingredient amid the global trend of sugar reduction and low-sugar consumption, and is widely applied in food & beverages, pharmaceuticals, daily chemicals, tabletop sweeteners and many other fields.

The transformation of a natural plant-based sweetener from wild strains to laboratory research subjects and then to globally accessible daily consumer products embodies the continuous efforts of scientific researchers, technical engineers, standard-setters and practitioners across the entire industrial chain worldwide. Hereby, we pay high tribute to all individuals, research teams, institutions and industrial enterprises who have dedicated themselves to fundamental stevia research, ingredient extraction, process improvement, safety assessment, regulatory certification, standard formulation, application R&D and global market promotion throughout the industry's evolution. In compliance with industry competition rules and corporate privacy protection principles, specific enterprise names are omitted in this section. We extend special recognition to all domestic and overseas enterprises that have made outstanding contributions to the development of this sector.

Honor Roll of Pioneers

(I) Core Scientists and Researchers (Chronological Order of Research Achievements)

1. ***Antonio Bertoni (Paraguay, Botanist)***

The first discoverer of stevia plant and steviol glycosides. In 1887, he conducted systematic botanical nomenclature and characteristic documentation on the traditionally consumed stevia plant native to Paraguay. He verified that the leaves of this Asteraceae plant deliver intense natural sweetness, distinct from conventional sweet plants. He was the first to formally introduce stevia and its sweet properties to academic circles, unlocking the door to scientific research on stevia and serving as the founding father of stevia traceability studies.

2. ***Constantin F. Avé Lallemant (France, Phytochemistry Expert)***

Pioneer in preliminary isolation of steviol glycosides. From the late 19th century to the early 20th century, he took the lead in crude extraction experiments on sweet substances from stevia leaves via traditional solvent extraction methods, obtaining crude sweet extracts. He initially verified their thermal stability, solubility and basic taste profiles, and distinguished stevia extracts from traditional sweet substances including sucrose and glycyrrhizin, accumulating original experimental data and base samples for subsequent isolation of active monomers.

3. ***M. Bridwell (United States, Expert in Carbohydrate and Natural Product Chemistry)***

Forerunner in monomer separation and structural analysis of steviol glycosides. In 1931, his team isolated high-purity crystalline primary sweet components from dried stevia leaves for the first time and formally named them Stevioside. They accurately measured core physicochemical parameters, sweetness multiples and basic molecular frameworks, and first confirmed stevioside as a terpene glycoside natural sweetener, fully identifying the source of stevia's sweetness. This breakthrough filled the research gap in the chemistry of stevia's core ingredients and laid the fundamental theoretical foundation for in-depth subsequent research and industrial extraction.

4. ***Fumio Tanaka (Japan, Leading Scholar in Natural Product Chemistry)***

Trailblazer of systematic chemical research and industrialization technology for stevia. During the 1950s and 1960s, he led his team to separate all fractions of steviol glycosides, isolating and identifying more than ten secondary glycosides including Rebaudioside A, Rebaudioside C and Steviolbioside, with complete analysis of their chemical structures, sweetness levels, flavor profiles and physicochemical disparities. Meanwhile, he optimized parameters for water and alcohol extraction processes, drastically boosting extraction yield and crude product purity. In the mid-1960s, he spearheaded the construction of the world's first small-scale industrial stevia extraction production line, realizing the leap from laboratory extraction to mass industrial production and launching the era of stevia industrialization.

5. ***Tadashi Sakamoto (Japan, Expert in Food Safety and Toxicology)***

Founder of the early safety evaluation system for stevia. From the 1960s to the 1970s, he presided over acute toxicity, subchronic toxicity, metabolic tests and animal feeding trials on steviol glycosides, initially clarifying their metabolic pathways, accumulation characteristics and fundamental safety thresholds in organisms. His research confirmed no obvious toxic side effects under regular consumption dosages, providing critical toxicological data that supported Japan's pioneering approval of stevia as a food additive. He stands as a core early advocate for the compliant application of stevia.

6. ***Luis R. Hernández (Paraguay / United States, Expert in Natural Extract Processing Technology)***

Innovator of large-scale stevia extraction processes. In the 1970s, addressing pain points of traditional alcohol extraction such as high costs, solvent residues and low extraction

efficiency, he developed a new process combining hot water leaching and flocculation impurity removal. This streamlined production workflows, cut raw material losses and manufacturing costs, adapted to continuous large-scale industrial production, kickstarting the deep processing industry of stevia in its South American origin and enabling widespread commercial circulation of stevia.

7. Jean-Marie Veyrat (Switzerland, Invited Food Chemistry Expert of JECFA)

Leading scholar in global safety assessment and compliance certification of stevia. From the 1980s to the early 21st century, he took charge of compiling decades of global toxicological, metabolic, clinical and long-term feeding trial data, and led multiple rounds of JECFA safety re-evaluations on stevia. He systematically studied the in-vivo metabolism and potential risks of steviol glycosides and steviol, scientifically defined the Acceptable Daily Intake (ADI), and formulated a full set of safety standards covering ingredient specifications, purity indicators and residue control. He led compliance filings and additive coding approvals for the EU, Australia and other regions, establishing a universally applicable global safety evaluation framework for stevia, making him the pivotal scholar behind the worldwide compliant adoption of stevia.

8. Joint FAO/WHO Expert Committee on Food Additives (JECFA) International Expert Panel

The authoritative international team that formulated global standards and safety specifications for stevia. JECFA released its first interim evaluation conclusion on stevia in 1984, followed by multiple rounds of data updates and re-evaluations. In 2008, the committee formally established the ADI value for steviol glycosides, unified global definitions of stevia fractions, quality indicators, detection methods, residue limits and usage specifications, and set separate standards for different product grades including total steviol glycosides and Rebaudioside A. This resolved the fragmentation of global standards and created unified rules for cross-border trade and global food applications of stevia.

9. Expert Team of China National Research Institute of Food and Fermentation Industries (1980s–1990s)

Foundational team that introduced stevia technology and realized domestic industrialization in China. In the 1980s, the team pioneered stevia introduction, cultivation trials and localized extraction process research, overcoming core domestic technologies including water extraction, filtration, decolorization and concentration tailored to local raw materials and breaking overseas technological monopolies. They established China’s first complete set of stevia detection methods and basic quality evaluation systems, completed early toxicological re-verification trials, facilitated stevia’s inclusion in China’s food additive catalog, and achieved the breakthrough of the domestic stevia industry from scratch.

10. Professor Qinlu Lin (Central South University of Forestry and Technology, China)

Authoritative domestic expert on stevia refining grading and fraction optimization. Having long dedicated his research to natural plant extracts and separation & purification

of steviol glycosides, he led the development of core technologies including macroporous resin adsorption separation, membrane refining and chromatographic grading starting from the 1990s. These technologies enabled efficient separation of individual steviol glycoside fractions and significantly elevated the content of high-value Rebaudioside A, resolving longstanding industry pain points of bitter and lingering aftertaste in domestically produced stevia. He continuously optimized decolorization and impurity removal processes, bringing the quality of Chinese refined stevia on par with top international products and laying the technical foundation for China's high-end stevia sector.

11. Senior Engineer Lubai Zhang (Shandong Huayang Biotechnology Co., Ltd., China)

Leading figure in large-scale industrialization and export of Chinese stevia. From the late 1990s to the early 2000s, he led his team to upgrade complete industrial technologies including continuous leaching, automated refining and energy-saving concentration, constructing large standardized mass-production bases for stevia in China. He presided over the establishment of a product grading system, launching a full product line covering crude stevia, refined stevia and high-RA stevia, opening overseas export channels and transforming China into the world's core producer and exporter of stevia.

12. Senior Engineer Shouxue Li (Qingdao Runhao Stevia High-Tech Co., Ltd., China)

Innovative expert in green production and deep processing of stevia. Starting in the 2010s, he focused on clean production, comprehensive by-product utilization and low-residue processing technologies, developing water-saving countercurrent extraction and solvent-free refining processes to cut manufacturing energy consumption and pollutant emissions. He led the R&D of compound stevia sweeteners, microencapsulated stevia and high-solubility premium products, expanding segmented application scenarios in pharmaceuticals, special medical foods and daily chemicals, and driving the industry's shift toward green, functional and high-end development.

(II) Core Research Institutions and University Teams

1. National Institute of Botany of Paraguay (Paraguay)

The birthplace of original stevia research. Since the 19th century, it has sustained research on stevia germplasm resources, growth habits and plant breeding, preserving the world's earliest original stevia germplasm. It provides botanical foundations for artificial introduction and large-scale cultivation of stevia and serves as the core upstream research institution within the stevia industrial chain.

2. Natural Products Laboratory, Faculty of Agriculture, The University of Tokyo (Japan)

Core platform for stevia chemical research and first-generation industrialization technologies. During the 1950s–1970s, the laboratory completed full fraction analysis and systematic physicochemical property research of steviol glycosides, developed initial extraction and refining processes, and built the world's first industrial production line. It

enabled the first commercialization of stevia in Japan and spearheaded early stevia technological development across Asia.

3. ***Swiss Federal Food Safety Institute (Switzerland)***

Benchmark institution for global stevia safety assessment. It undertakes core JECFA test projects, completes multiple rounds of long-term toxicological, metabolic and clinical studies, and releases globally recognized safety assessment reports that support regulatory access for stevia in major markets including the EU, North America and Oceania, delivering core scientific backing for stevia's global compliance.

4. ***Natural Sweetener Research Center, United States Department of Agriculture (USA)***

Leading institution for stevia application technology and compound formulation R&D. It specializes in stevia flavor improvement, taste optimization and compound systems blending stevia with sucrose, sugar alcohols and erythritol, addressing drawbacks such as lingering bitter aftertaste and delayed sweetness of high-potency sweeteners. It promotes in-depth stevia applications in mainstream end products including beverages and snack foods, and leads innovation in application technologies for the North American market.

5. ***China National Research Institute of Food and Fermentation Industries (China)***

China's cradle of stevia technology. In the 1980s, it launched domestic stevia research initiatives, accomplishing technology introduction, process localization, national standard pre-research and safety re-evaluation, and establishing China's first complete technical and detection system for stevia, facilitating the birth of the domestic industry from zero.

6. ***College of Food Science and Engineering, Central South University of Forestry and Technology (China)***

Top domestic scientific research platform for stevia refining and grading technologies. It iterates technologies in resin separation, membrane treatment, chromatographic purification and component modification, overcoming mass-production barriers for high-purity Rebaudioside A. It delivers core technical support for quality upgrading of domestic high-end stevia and helps the industry escape low-end price competition.

Part Two: R&D History of Stevia

(I) Plant Discovery and Preliminary Exploration Stage (1887 – 1940s)

Research on stevia originated from traditional folk consumption practices in Paraguay, South America and systematic modern botanical exploration. In 1887, Paraguayan botanist Antonio Bertoni completed formal botanical nomenclature of stevia and fully documented its intense natural sweetness, marking stevia's official entry into modern scientific research. Over the following decades, scholars from Europe and the United States conducted continuous field observations and simple extraction trials, preparing

crude stevia extracts via traditional solvent methods and initially verifying their sweetness intensity, thermal stability and basic physicochemical traits.

Restricted by the phytochemical separation technologies of the era, researchers could only obtain impure mixed crude extracts, unable to isolate individual sweet active monomers or conduct systematic chemical structural analysis and toxicological safety verification. Global research centered on botanical documentation and sensory evaluation of crude extracts, lacking foundations for industrial development. Nevertheless, this phase validated stevia's edible value and accumulated fundamental experimental samples, laying prerequisites for subsequent refined separation of active ingredients. In 1931, the team led by American scholar M. Bridwell successfully isolated the first high-purity crystalline sweet substance named stevioside, definitively identifying the core sweet component of stevia and advancing stevia research into the era of fine organic chemical analysis.

(II) Component Analysis and Budding Industrialization Stage (1950s – 1960s)

Starting in the 1950s, Japan emerged as the global hub for stevia research, witnessing pivotal technological breakthroughs for the industry. Fumio Tanaka's team systematically split all fractions of steviol glycosides, isolating and identifying multiple associated glycosides including Rebaudioside A and Rebaudioside C, and fully analyzing their molecular structures, sweetness gradients, flavor differences and physicochemical characteristics. The team constructed a complete chemical fraction map of steviol glycosides, perfecting the fundamental theoretical framework of stevia chemistry.

The focus of technological R&D simultaneously shifted from laboratory micro-extraction to complete industrial process development. Researchers continuously optimized full production workflows including water extraction, alcohol extraction, solid-liquid separation and concentration, effectively mitigating industry challenges of low extraction yield and high impurity content. In the mid-1960s, the world's first industrial stevia extraction production line was put into operation in Japan, enabling small-scale commercial mass production of stevia. During the same period, Japan completed the first round of systematic toxicological trials confirming stevia's safety under regular consumption dosages, securing official approval for its domestic use as a food additive. Products of this stage were predominantly crude stevia with mixed glycoside fractions and prominent flavor defects, limiting applicable scenarios. Even so, this period formally launched the industrial development of stevia.

(III) Process Upgrading, Safety Verification and Regional Popularization Stage (1970s – 1980s)

From the 1970s to the 1980s, the global stevia industry formed a development landscape featuring Japan's technological leadership, South America's raw material supply and synchronous research progress in Europe and America, with two core parallel industry priorities: process iteration and global safety evaluation. On the processing front,

researchers in South and North America innovated the hot water leaching plus flocculation impurity removal process, drastically cutting comprehensive manufacturing costs and driving rapid expansion of global stevia production capacity. Japan continued to deepen refining and purification technologies, realizing preliminary simple separation of different glycoside fractions, and refined stevia with mild off-notes and high sweetness gradually entered the market.

The construction of safety and regulatory systems stood as the core work of this era. Tadashi Sakamoto's team completed multi-dimensional systematic toxicological and in-vivo metabolic trials, with cross-verification conducted by European and Swiss research institutions. JECFA formally intervened in unified global safety assessment, releasing interim safety evaluation conclusions and preliminary consumption range and limit standards for stevia in 1984. Japan, South Korea and multiple Southeast Asian countries successively approved stevia as a legal food additive, with products widely applied in local beverages, candies and pickled vegetables, completing regional market penetration across East Asia and South America. Market circulation products of this period remained dominated by mid-to-low-end crude extracts and ordinary refined stevia, while mass-production technologies for high-purity Rebaudioside A were not yet mature.

(IV) Global Regulatory Maturity and Rise of Domestic Chinese Industrialization Stage (1990s – Early 2000s)

In the 1990s, the global regulatory framework for stevia gradually improved, with cross-border trade barriers continuously diminishing. JECFA updated its toxicological assessment database iteratively; the EU, Australia, New Zealand and other regions sequentially approved steviol glycosides as compliant food additives with dedicated supporting usage standards. The United States gradually opened pilot applications, with market access channels to all major global consumer markets largely established. Overseas research focused on high-end glycoside fraction development, with Rebaudioside A emerging as the global core R&D target due to its sucrose-like flavor and superior palatability.

China's domestic industry simultaneously embarked on independent development and rapid expansion. Stvia introduction and localized cultivation trials were completed domestically in the 1980s. In the 1990s, institutions including China National Research Institute of Food and Fermentation Industries digested overseas processes and developed independent technologies, breaking foreign technological monopolies as multiple domestic mass-production lines went online, realizing full domestic production of stevia. Universities such as Central South University of Forestry and Technology overcame core technologies of resin adsorption and deep decolorization refining, steadily lifting the quality of Chinese stevia finished products. Around 2000, leveraging comprehensive cost advantages in land, raw materials and labor, China rapidly expanded production capacity, transforming from an importer to the world's core producer and exporter of stevia. Domestic products of this phase were primarily mid-to-low-end stevia exported in bulk to Japan, South Korea and Southeast Asia, forming an initial global industrial division of labor between China and foreign players.

(V) Technological Overtaking, High-End Upgrading and Global Leadership Stage (2010s – Present)

After 2010, a worldwide boom in low-sugar and sugar-reduction consumption erupted, propelling the stevia industry into a high-growth cycle. China achieved all-round overtaking in technology, production capacity and product quality, evolving into the core engine driving global stevia industry development. Technologically, domestic research institutes and industrial R&D teams jointly conquered advanced purification technologies including membrane separation, continuous chromatographic refining and simulated moving bed separation. The purity of finished Rebaudioside A stably exceeded 98%, fundamentally resolving traditional flavor drawbacks such as bitterness and delayed sweetness, bringing high-end product quality in line with top international benchmarks. Green manufacturing processes including water-saving countercurrent extraction, waste heat recovery and resource utilization of by-products gained full industry-wide adoption, significantly cutting manufacturing energy consumption and pollutant emissions. In terms of product systems, China built a full-spectrum product matrix covering crude stevia, conventional refined stevia, high-RA high-purity stevia, rare glycoside monomers, compound sweeteners and microencapsulated stevia, fully meeting market demands spanning low-end bulk commodities, mid-tier circulation goods and high-end customized products. On standardization, China continuously revised national food safety standards, with stringent indicators and supporting detection methods fully aligned with international norms, and some limit standards stricter than global universal specifications. Currently, China accounts for over 80% of the world's total stevia production capacity, ranking as the globe's largest country for stevia cultivation, stevia manufacturing, domestic consumption and product export. Large volumes of high-purity premium stevia are supplied to high-end food, beverage and pharmaceutical markets in Europe and America, completely reshaping the global industrial competition landscape. Meanwhile, the industry continues to explore the physiological bioactivities of steviol glycosides, shifting product positioning from single sweetening ingredients to functional natural health raw materials.

Part Three: Commercialization Development History of Stevia

(I) Folk Utilization and Technology Accumulation Period (1887 – 1950s)

During this period, stevia was only consumed locally as a traditional folk sweet plant in its South American origin, with no standardized goods circulated across regions. Global academic research focused on fundamental botanical documentation and simple extraction trials, accomplishing the discovery and basic qualitative analysis of core sweet components. Restricted by immature separation and purification technologies and complete chemical equipment, large-scale mass production was unfeasible, precluding commercial circulation value. All research of this era centered on accumulating basic theories and experimental samples, only laying preliminary technical and data groundwork for subsequent industrialization and commercial launch.

(II) Birth of Industrialization and Initial Regional Commercialization Period (1960s – 1980s)

The 1960s marked the first year of stevia commercialization, as the world's first industrial extraction production line was completed and put into operation in Japan, bringing standardized stevia products to consumer markets for the first time. Early circulating products were mainly crude extracts with high manufacturing costs and poor flavor performance, limited to niche local food categories in Japan. From the 1970s to the 1980s, relying on native planting resources, South American origins developed primary processing industries, boosting total stevia output while lowering unit production costs, with products gradually exported to East and Southeast Asian markets.

With the release of safety trial data and compliance approvals across multiple countries, commercial application scenarios for stevia continuously expanded to mainstream food categories including candies, preserved fruits, bottled beverages and condiments. Nevertheless, the overall global market scale remained limited in this phase. Japan monopolized high-end purification technologies, high-value products and core consumer markets, leaving the industry characterized by niche, regional and low-end commercial traits without a complete global industrial system.

(III) Global Regulatory Implementation and Market Expansion Period (1990s – 2009)

Starting in the 1990s, the global compliance system for stevia was fully established. Authoritative bodies including JECFA and the EU successively released unified quality standards and lifted usage restrictions, eliminating core barriers to cross-border trade and officially launching the global commercialization of stevia. Europe and America gradually opened market access for the additive, with international R&D teams focusing on high-purity Rebaudioside A products to target high-end beverage and health food segments.

China's domestic commercialization accelerated concurrently. Local enterprises completed technology introduction and independent mass production, capturing the global mid-to-low-end raw material market by virtue of comprehensive cost advantages with surging export volumes, emerging as the world's core supplier of bulk stevia raw materials. This phase formed a global commercial division of labor: Europe, America and Japan controlled high-end technologies and premium consumer markets, while China and South America supplied bulk basic raw materials. The overall industry market scale expanded steadily, elevating stevia from a regional niche ingredient to a globally universal natural sweetener.

(IV) Industry Boom and Landscape Restructuring amid the Sugar-Reduction Wave (2010 – 2019)

Rising global consumer awareness of healthy living and successive rollouts of national sugar-control policies became the core driving forces behind explosive growth of the

stevia industry. Featuring natural plant origins and zero calories, stevia became the preferred sweetening ingredient for all sugar-reduced formulations, triggering sharp growth in global end-market demand.

Leveraging technological breakthroughs, complete industrial chains and large-scale manufacturing advantages, China's domestic R&D and manufacturing sectors rapidly penetrated high-end markets. Stable mass production of high-purity Rebaudioside A enabled bulk overseas exports, breaking long-term foreign monopolies on premium products. Domestic industrial R&D players simultaneously upgraded their business models, transforming from single raw material suppliers into integrated service providers offering raw material supply, formula R&D and application solution output. Traditional overseas industrial players gradually scaled back bulk base production capacity, shifting focus to high-value segmented tracks including ultra-high-purity rare glycosides, specially modified glycosides and customized compound products. The global commercial landscape underwent profound restructuring, with China emerging as the world's core hub for stevia production and sales, dominating supply of both bulk raw materials and mainstream premium products.

(V) High-Quality Development with Refinement, Functionalization and Greenization (2020 – Present)

Over the past five years, the global stevia industry has moved beyond simple capacity expansion and fully entered a high-quality refined development stage. On the market side, end-demand segmentation continues to deepen. Beyond traditional food and beverage tracks, products have penetrated high-value segmented scenarios including foods for special medical purposes, sugar-free oral pharmaceuticals, oral care, daily cleansing products, functional pet foods and individually packaged tabletop sweeteners. On the product side, the industry advances technologies for rare glycoside monomer extraction, flavor modification, compound synergism and dosage form optimization, with new stevia variants including microencapsulated, high-solubility and sustained-release products continuously launched through iteration.

On the production side, green low-carbon manufacturing has become a mandatory industry development standard. Water-saving countercurrent extraction, material recycling and solvent-free purification processes have gained full industry-wide adoption, with tightening control standards for clean production. On trade and compliance fronts, market access indicators for plant extracts and food additives across all countries grow increasingly stringent, forcing the entire industrial chain to upgrade quality control and traceability management capabilities. Concurrently, scientific research continuously validates physiological functions of steviol glycosides including antioxidant activity and auxiliary blood sugar regulation, elevating the core value of products from "high-potency sugar substitute raw materials" to "natural functional healthy ingredients." The industry's growth drivers have evolved from single demand pull to multi-dimensional forces including technological innovation, functional empowerment and comprehensive value enhancement.

Part Four: Construction History of Industry Standard Systems

(I) Establishment of International Standard Systems (1980s – 2009)

The global international standard system for stevia takes JECFA evaluation specifications as its top-tier foundational benchmark. In 1984, JECFA released its first interim safety assessment report and basic quality standards for steviol glycosides, unifying product definitions, core quality indicators and supporting detection methods for stevia worldwide for the first time. Following multiple rounds of supplementary toxicological trial data and updated research findings on glycoside fractions, JECFA formally established the ADI value for steviol glycosides in 2008, issuing a complete set of control standards covering product quality specifications, fraction limits, heavy metals, microorganisms and processing residues, serving as the universal top-tier global norm.

Shortly after the release of JECFA standards, the EU issued dedicated food additive standards and assigned official coding to steviol glycosides. Regional specifications including the United States FCC, Japanese Food Additives Codex and Australian FSANZ sequentially incorporated stevia categories, refining indicator thresholds and applicable food scopes aligned with local consumption characteristics. A fully formed, mutually recognized and multi-layered international standard system unified universal rules governing global stevia production, detection, cross-border trade and end-use applications, laying institutional groundwork for worldwide circulation of stevia.

(II) China’s Standards: From Blank Slate and Follow-Up to Global Leadership (1990s – Present)

In the 1990s, alongside the official launch of China’s domestic stevia industry, China initiated the compilation of industry standards. The first batch of unified industry standards was implemented, completely rectifying the industry chaos of inconsistent product quality without unified domestic specifications and initially standardizing domestic production, operation and market circulation order.

Since the 21st century, aligned with domestic industrial iteration rhythms and updates to international standards, China has continuously issued and revised the GB 1886 series national food safety standards for steviol glycosides, establishing separate specifications for regular steviol glycosides, refined steviol glycosides and products of varying purity gradients. These standards detail full-dimensional quality control indicators including Rebaudioside A content, total glycoside proportion, moisture, ash, organic solvent residues, heavy metals and microorganisms, adopting mainstream international high-performance liquid chromatography as supporting detection methods, with multiple limit control indicators stricter than universal global international standards. Meanwhile, steviol glycosides have been consistently included in GB 2760 Standards for Uses of Food Additives, clarifying permitted usage ranges across all food categories to enable full-compliance application of all product variants.

At present, China’s stevia standard system comprehensively covers the full industrial chain spanning upstream stevia cultivation, midstream extraction and refining, laboratory

detection and downstream end-product application, ranking globally leading in standard completeness, control stringency and practical implementability. It not only regulates high-quality development of China's domestic industry but also acts as a reference template for standard formulation in numerous other countries, guiding the direction of global stevia standardization.

Part Five: Expansion of End-Use Applications and Deepening Functional Research

(I) Basic Sugar Substitution Stage (1960s – 1980s)

In the early industrial phase, stevia was positioned as an affordable basic sweetener alternative to sucrose, with its core value lying in partial replacement of sucrose in formulations to cut manufacturing costs of end products. Restricted by low product purity, prominent flavor defects and blank research on physiological functions, applicable scenarios were highly limited, concentrated solely on traditional local candies, preserved fruits, pickled vegetables and low-end bottled beverages in Japan and Southeast Asia. This stage only exploited stevia's fundamental sweetening function with no R&D related to health attributes, and product application logic centered on formula cost reduction and simple sugar replacement.

(II) Regulatory Compliance and Expanded Application Scenarios Stage (1990s – 2009)

With global safety compliance certifications finalized and iterative advances in stevia refining and purification technologies, major improvements were made to product flavor flaws, continuously broadening application boundaries. Beyond traditional snack foods, products gradually entered mainstream mass-market categories including bottled beverages, dairy products, baked goods and individually packaged tabletop sweeteners. Leveraging core traits of zero calories, non-postprandial blood glucose elevation and non-cariogenicity, the industry developed specialized sugar-free foods and health supplements targeting diabetic and weight-management populations.

Global research institutions and industrial R&D teams launched systematic research on stevia's physiological properties, confirming its advantages of low glycemic response, low insulin stimulation and oral health friendliness, upgrading product positioning from "cheap generic sugar substitutes" to "specialized healthy sweetening ingredients." Concurrent compound formulation R&D blended stevia with sucrose and polyols to optimize taste defects, with compound sweetener formulas gradually commercialized.

(III) High-End Segmentation and In-Depth Functional Exploration Stage (2010 – Present)

The global sugar-reduction consumption trend has driven comprehensive transformation of stevia applications toward high-end, refined and functional development. Within the food and beverage sector, high-purity stevia is widely applied in premium sugar-free drinks, meal replacement foods, low-calorie snacks, frozen desserts and functional dairy products. In special dietary fields, it has deeply penetrated high-value segmented tracks including foods for special medical purposes, infant complementary foods and weight-management foods.

Pharmaceuticals and daily chemicals have emerged as brand-new growth segments. Benefiting from natural safety and strong physicochemical stability, stevia serves as a taste-masking excipient for oral syrups, lozenges and chewable tablets, while achieving large-scale application in toothpaste, mouthwash, skincare products, body care and other daily chemical categories. Emerging application scenarios continue to break new ground, with steadily rising penetration in functional pet foods, plant-based foods and prefabricated dish seasoning packets.

On functional research, beyond established basic traits of zero calories, non-cariogenicity and low glycemic index, potential physiological bioactivities of steviol glycosides including antioxidant, anti-inflammatory and gut microbiota-regulating effects have been progressively scientifically validated. The industry develops differentiated exclusive products centered on unique physiological functions. Compound formulation technologies have matured, with blended sweeteners combining stevia with erythritol, mogrosides, dietary fiber and prebiotics emerging as mainstream market solutions. These formulations deliver synergistic optimization across three dimensions: taste, physiological functionality and production costs, continuously expanding the value boundary of the entire stevia industrial chain.

Part Six: Future Outlook for the Industry

After over a century of systematic scientific exploration and more than seven decades of dedicated industrial development, stevia has achieved leapfrog growth from a wild South American plant and laboratory research subject to a regional niche ingredient, ultimately evolving into a mainstream global natural high-potency sweetener. A complete, mature full industrial chain system has been established, covering germplasm breeding and cultivation, extraction and refining, grading and purification, compound deep processing, end-formula application and global compliance standards. Generations of global scientific researchers and industrial practitioners have sustained technological breakthroughs, forming a competitively robust stevia industrial landscape within the natural sweetener track.

Looking ahead, normalized global sugar-reduction policies, widespread natural health consumption philosophies and mandatory dual-carbon green development requirements will continuously propel the stevia industry toward higher-quality growth. Five core development trends will shape the sector’s future:

1. ***Continuous High-Precision Technology Advancement***

Focus on R&D of cutting-edge technologies including separation of rare glycoside monomers, molecular component modification, precise flavor improvement and biosynthesis, to consistently enhance product palatability and added value and develop differentiated high-end specialty products.

2. ***Comprehensive Green Production Transformation***

Scale up complete sets of water-saving, energy-saving, material recycling and solvent-free purification processes, perfect a high-value comprehensive utilization system for stevia by-products, and build a low-carbon, eco-friendly and recyclable modern intelligent manufacturing model.

3. ***Segmented and Customized Product Development***

Develop exclusive-spec raw materials, customized compound formulas and new dosage-form products tailored to distinct end-use tracks and differentiated consumer groups, accurately matching refined and diversified market demands.

4. ***Deepened Functional Value Exploration***

Continuously uncover diverse healthy physiological bioactivities of steviol glycosides, advance product positioning upgrades from single sweetening ingredients to functional healthy raw materials, and deeply expand high-value application fields including special medical diets, general health care and biomedicine.

5. ***Integrated Global Layout***

Drawing on complete industrial chain and leading technological advantages, domestic industrial players will accelerate global deployment of production capacity and services, export mature manufacturing processes, national standard systems and supporting application technologies, and continuously consolidate global industrial leadership.

In the medium and long term, China will retain its core leading position in the global stevia industry, spearheading industry technological iteration, standard upgrading, application innovation and global market expansion. Supported by core differentiated strengths of natural origins, health benefits and safety, stevia will continuously unlock industrial value amid the global shift toward low-sugar diets and the booming general health industry, facilitating the healthy and sustainable transformation of food, pharmaceutical, daily chemical and numerous other sectors worldwide.