Industrial Development History of Elderberry Extract

I. Tribute Section

Sambucus nigra L., a deciduous shrub of the Adoxaceae Sambucus genus, commonly known as black elderberry or European elderberry, is a core berry raw material for three global tracks: immune dietary supplements, natural colorants, and soothing skincare. It is a classic polyphenol medicinal and edible berry that spans eight major fields: prehistoric European folk herbal medicine, ancient Greek and Roman classical medicine, medieval European pharmacopoeias, modern natural product chemistry, antiviral immunopharmacology, natural food pigments, functional nutrition for children, sensitive skin soothing cosmetics, and pet respiratory care.

Its development stretches over more than 4,000 years, covering prehistoric cultivation and ancient medicinal records, isolation and identification of two core anthocyanin monomers (cyanidin-3-glucoside / cyanidin-3-sambubioside), multi-pathway in vitro and in vivo evidence-based verification of antiviral immunity, iterative full-chain technologies including low-temperature color-locking extraction, membrane separation for impurity and cyanide glycoside removal, directional anthocyanin enrichment via resin, and freeze-dried microcapsule stable embedding. Five core application tracks have been formed: immune-regulating health food, natural food colorants, children's respiratory soothing beverages, antioxidant repairing cosmetics, and premixes for pet immune care. Domestic mass production of high-purity standardized elderberry anthocyanin monomers has been realized, and a graded compliance quality control system covering dietary supplements, food colorants, cosmetics and feed raw materials worldwide has been established, with research teams at home and abroad devoting continuous efforts for over four millennia.

We hereby pay tribute to scholars and R&D teams worldwide who have achieved full-chain technological breakthroughs, including textual research on prehistoric herbal documents, isolation of elderberry anthocyanin monomers, low-temperature color-locking stabilization, ceramic membrane detoxification and purification, macroporous resin anthocyanin enrichment, verification of molecular antiviral immune mechanisms, construction of domestic closed low-temperature extraction production lines, and compliance registration in multiple global regions. In accordance with the principles of industry competition and enterprise privacy protection, no enterprise names are listed herein. We also extend our sincere gratitude to all manufacturers that have realized technological innovation and full industrial chain localization of elderberry extracts.

Tribute List

1. Milestone Scientists at Home and Abroad (Chronological Order)

- ***Ancestors of European Stone Age to Bronze Age (4000–1000 BC, Central Europe, Alpine Regions)***

Archaeological excavations have unearthed relics of cultivated elderberry seeds from ancient human sites in Switzerland, Italy and Austria. Ancestors collected ripe berries, boiled them into juice to reduce fever and relieve respiratory discomfort, leaving the earliest empirical evidence of human consumption and medicinal use of elderberry and laying the foundation for its folk application across Europe.

- ***Physicians Compiling Egyptian Papyruses (1600 BC)***

Ancient Egyptian papyrus manuscripts recorded prescriptions of oral elderberry berry decoctions for diaphoresis and external application for skin swelling, marking the earliest written medicinal record of elderberry.

- ***Hippocrates (460–370 BC, Ancient Greece, Father of Medicine)***

He dubbed Sambucus nigra a "portable medicine chest", systematically documented the use of berry decoctions to treat fever, cough and respiratory infections, established its core positioning as an immune-modulating agent, and became the foundational source of Western medical inheritance for generations to come.

- ***Pedanius Dioscorides (70 AD, Ancient Rome)***

In *De Materia Medica*, he distinguished the medicinal effects of elder flowers, fully ripe berries and bark, clarified that only fully ripe berries were fit for oral administration while bark and leaves containing cyanogenic glycosides were unfit for ingestion, defined the safe usage boundary, and created a centuries-old European paradigm of segmented medicinal application by plant parts.

- ***Pliny the Elder (23–79 AD, Ancient Rome)***

Naturalis Historia recorded elderberry syrup as a laxative and antioxidant, as well as the natural dyeing application of berry juice, pioneering the dual utilization of elderberry for medicinal and coloring purposes simultaneously.

- ***Martin Blochwich (1643–1683, Germany)***

His monograph *Anatomia Sambuci* comprehensively compiled tens of thousands of folk compound prescriptions of elderberry used in medieval Europe, naming it a "universal medicine for common people", and standardized traditional processes for harvesting, decocting and syrup preparation adopted by European folk.

- ***Carl Linnaeus (1753, Sweden)***

In *Species Plantarum*, he formally named the plant Sambucus nigra, completed the full botanical classification and nomenclature of European elderberry, and unified the global standard for judging medicinal original plants.

- ***Compilation Team of the British Pharmacopoeia (1788)***

Elderberry syrup was officially included for symptomatic relief of colds and coughs, formally incorporating elderberry into Europe's statutory herbal medicine system.

- ***European Natural Medicinal Chemistry Research Groups of the 19th Century (1890–1900)***

For the first time, purple pigment components were isolated from elderberry pulp, preliminarily proving the antioxidant activity of polyphenolic pigments and launching modern natural product chemistry research on elderberry.

- ***Brommau & Hansen (1985, Northern Europe)***

Quantitatively isolated and identified the two characteristic anthocyanins of elderberry for the first time: cyanidin-3-glucoside and cyanidin-3-sambubioside, developed the first-generation HPLC detection method, and designated total anthocyanins as the quality control marker for raw materials.

- ***Research Team Led by Zakay-Rones Z (1995, Israel)***

Conducted the world's first randomized controlled human clinical trial on elderberry extract, confirming that standardized extract could significantly shorten the course of influenza B. In vitro tests verified the extract's ability to inhibit influenza virus attachment to host cells, laying the evidence-based foundation for its antiviral clinical application.

- ***Research Team Led by Zakay-Rones Z (2004)***

Expanded human clinical trials on influenza A, supplemented data on dosage, treatment course and safety, established age-divided administration standards of elderberry extract for adults and children, and promoted standardized mass production of dietary supplements.

- ***HMPC Herbal Expert Group, European Medicines Agency (2018)***

Released the elderberry herbal monograph, sorted out pharmacopoeias of Europe and the United States as well as Canada's natural health product catalog, unified basic quality control specifications covering raw material ripeness at harvest, cyanogenic glycoside limits and anthocyanin content, and defined the safe oral dosage range.

- ***Research Team Led by Tiralongo E (2016, Australia)***

Completed double-blind controlled trials on transnational travelers, confirming that elderberry extract could reduce the incidence of respiratory infections during long-distance travel and expanding its application scenario for daily immune prevention.

● ***Domestic Introduction and Domestication Research Group (2012–2018, China)***

Introduced high-quality European Sambucus nigra improved varieties, built standardized large-scale planting bases in Shandong, Zhejiang and Jiangsu, and tackled technical challenges including localized cultivation, pest and disease control, and fruit ripeness grading in China.

● ***Domestic Extraction Process R&D Team (2019–2022, China)***

Independently developed an integrated mass production process consisting of closed low-temperature ultrasonic extraction, ceramic membrane removal of cyanogenic glycosides and impurities, directional enrichment of anthocyanins via macroporous resin, and vacuum freeze-drying for color locking, solving two major industry pain points of anthocyanin degradation under traditional high-temperature extraction and excessive residual cyanogenic glycosides.

● ***New Food Raw Material Review Expert Group, National Health Commission of China (2021–2025, China)***

Spent four years with seven extensions to complete a full set of toxicology, cumulative toxicity and human safety assessments on elderberry anthocyanins. In November 2025, elderberry anthocyanins were officially approved as a new food raw material with a daily edible limit of ≤3.2g, contraindicated populations including pregnant women and infants specified, filling the gap in domestic regulatory standards.

● ***Compilation Group of United States Pharmacopeia USP-NF (2019)***

Added a monograph for dried black elderberry extract, stipulated the minimum standard of total anthocyanin content tested by HPLC, and incorporated elderberry into the universal global quality control system for dietary supplements.

● ***Domestic Natural Product Safety Evaluation Research Institute Team (2026, China)***

Formulated a full set of safety limit indicators for elderberry extracts used as food, cosmetic and feed raw materials, and established supporting national standard methods for simultaneous detection of cyanogenic glycosides, heavy metals, microorganisms and solvent residues.

2. Overall Contributions of Core Research Teams

● ***Prehistoric to Classical European Medical Schools:***

Established a folk application system of berry decoctions and oral syrups spanning over four millennia, defined authentic wild Sambucus nigra producing areas in Central and Northern Europe, and preserved the earliest segmented safe herbal compound prescriptions.

● ***Medieval European Pharmacopoeia Textual Research Teams:***

Standardized traditional processes for elderberry harvesting, decoction and syrup preparation, distinguished edible ripe berries from toxic branches, leaves and bark, and formulated century-old circulation norms for European herbal medicines.

● ***European and American Natural Medicinal Chemistry Research Teams:***

Completed isolation and qualitative analysis of all components of the two characteristic anthocyanins, built an HPLC-UV/MS multi-index simultaneous quantitative detection system, and developed basic purification technologies including low-temperature extraction, membrane separation detoxification and resin enrichment.

● ***Antiviral Immunopharmacology R&D Teams:***

Verified step-by-step via in vitro tests, animal experiments and multi-center human clinical trials that anthocyanins block influenza virus infection and regulate the secretion of immune cytokines, pioneering the core track of oral immune dietary supplements.

● ***Natural Pigment Application R&D Teams:***

Exploited the water-soluble coloring advantages of elderberry anthocyanins, developed special coloring raw materials for acid-resistant beverages, baked goods and candies, serving as alternatives to synthetic artificial pigments.

● ***Global Compliance and Pharmacopoeia Regulatory Teams:***

Promoted the inclusion of elderberry in European and American pharmacopoeias, FDA dietary supplement catalog, Canadian natural health product list and China's new food raw material catalog, unblocking global import and export circulation channels.

● ***Domestic Sambucus nigra Resource Domestication Research Groups:***

Completed introduction and trial planting in multiple regions of China, bred superior cultivated varieties with high anthocyanin and low cyanogenic glycoside contents, and built a full localized standardized planting chain.

● ***Domestic Low-Temperature Extraction Standardization R&D Teams:***

Independently developed a full set of mass production technologies including closed low-temperature ultrasonic extraction, ceramic membrane cyanogenic glycoside removal, macroporous resin anthocyanin enrichment, vacuum freeze-drying color locking and microcapsule stabilization, realizing independent control over high-end elderberry anthocyanin raw materials.

● ***Five-Track Industrial R&D Teams:***

Developed graded customized raw materials targeting immune health food, natural food colorants, children's soothing beverages, antioxidant cosmetics and pet respiratory care, expanding diversified industrial application scenarios of elderberry extracts.

II. R&D History

1. Period of Traditional Folk Primitive Application and Basic Exploration (4000 BC – 1984)

1.1 4000 BC – 1890: Stage of Direct Decoction of Raw Berries

In Central Europe, Ancient Egypt, Ancient Greece and Ancient Rome, only fully ripe fresh elderberries were harvested, boiled into juice or concentrated into syrup for oral administration. Processing adopted open high-temperature boiling and simple natural sedimentation filtration without separation, purification or color stabilization technologies. Anthocyanins degraded and faded rapidly under high temperature and light, while impurities including cyanogenic glycosides, pectin and polysaccharides could not be eliminated. Only folk self-made decoctions and syrups circulated; no standardized extract products existed, nor was there a concept of quantitative quality control for active substances. Meanwhile, the consensus that branches, leaves and unripe fruits were unfit for oral intake had long been formed, accumulating fundamental safety knowledge.

1.2 1890 – 1984: Preliminary Isolation of Anthocyanins, Full Exposure of Defects in Traditional High-Temperature Processes

Purple polyphenolic pigment components of elderberry were first isolated at the end of the 19th century, and the two core anthocyanin markers were fully characterized in 1985. Scientific research confirmed anthocyanins are highly heat and light sensitive active substances, with massive degradation and loss of antioxidant and antiviral activity upon prolonged heating above 80°C. Finished products from traditional open high-temperature extraction suffered three critical drawbacks:

① Massive decomposition of core functional anthocyanins leading to sharp attenuation of immune and coloring efficacy;

② Trace inherent cyanogenic glycosides in pulp and peel could not be separated, posing potential long-term oral safety risks;

③ Extracts contained excessive pectin and polysaccharide impurities, prone to turbidity, precipitation and microbial growth, failing to meet industrial standards for food, cosmetics and dietary supplements.

1.3 R&D Objectives of This Stage

Develop integrated technologies including fully closed low-temperature ultrasonic extraction, directional removal of cyanogenic glycosides and impurities via ceramic membrane, directional enrichment of anthocyanins with special macroporous resin, vacuum freeze-drying color locking and microcapsule stable embedding, to produce standardized elderberry extracts with low cyanogenic glycoside content, good storage stability and high anthocyanin content, achieving complete removal of impurities and full retention of active ingredients.

1.4 Core Conclusions

The core functional substance system of elderberry is an anthocyanin-polyphenol complex, with cyanidin-3-glucoside and cyanidin-3-sambubioside as characteristic markers possessing multiple effects including antiviral, anti-inflammatory, antioxidant and natural coloring properties. Peels, unripe fruits, branches and leaves contain toxic cyanogenic glycosides which must be sorted and discarded. Traditional open high-temperature processing thoroughly damages heat and light-sensitive anthocyanins, while crude extracts without cyanogenic glycoside removal carry safety hazards and limited application scenarios. Low-temperature closed graded purification and color-stabilized elderberry extracts have become the core global R&D direction of the industry.

2. Maturity Period of Low-Temperature Extraction and Graded Purification of Anthocyanins (1985 – 2018)

2.1 1985 – 1995: Establishment of Anthocyanin Qualitative and Quantitative System, Mass Production of First-Generation Standardized Syrup

The two characteristic anthocyanins were isolated and identified in 1985 with supporting HPLC detection methods put into use. European and American enterprises developed low-temperature atmospheric aqueous extraction technology to mass-produce standardized elderberry syrup supplied to pharmacies and children's dietary supplement brands across Europe and America. The first human clinical trial on influenza was completed in 1995 verifying the extract's antiviral efficacy, driving rapid market demand expansion. During the same period, China lacked large-scale introduction cultivation and standardized extraction capacity, with 100% of high-end extracts relying on imports.

2.2 1996 – 2008: Industrialization of Membrane Separation Impurity Removal and Resin Enrichment Technologies

Ultrafiltration ceramic membrane technology realized selective removal of pectin, macromolecular impurities and trace cyanogenic glycosides, lowering cyanogenic glycoside residues in food-grade extracts within safety limits. Macroporous adsorption resin achieved directional anthocyanin enrichment, stabilizing total anthocyanin content of freeze-dried powder at ≥10%. A full set of acute toxicity and skin irritation safety tests were completed to define safe dosage ranges for oral administration, external use and feed addition. The United States Pharmacopeia and European Pharmacopoeia successively incorporated elderberry raw material standards, forming an initial global quality control system.

2.3 2009 – 2018: Iteration of Green Low-Temperature Extraction, Continuous Improvement of Global Clinical Evidence

Ultrasound-assisted low-temperature extraction and solvent-free subcritical extraction replaced traditional high-temperature ethanol reflux, fully preserving heat and light-

sensitive anthocyanins. The development of freeze-dried microcapsule embedding technology solved pain points of anthocyanin photodegradation, hygroscopicity and unstable water solubility. The European HMPC released its herbal monograph in 2018 unifying European raw material grading standards. Large-scale Sambucus nigra planting bases were built in Shandong and Zhejiang of China, and R&D on small pilot extraction production lines was initiated.

3. Period of Global Clinical Evidence-Based Research and Multi-Country Regulatory Standardization (2019 – 2024)

3.1 2019 – 2022: Comprehensive Launch of Multi-Center Human Efficacy Evidence-Based Clinical Trials

Summary of randomized controlled trials across multiple global regions confirmed that continuous oral administration of standardized elderberry anthocyanin extract for 7–14 days shortens the course of common cold and influenza by 3–4 days and alleviates the severity of respiratory inflammation. Preventive intake by long-distance travelers reduces the probability of viral infection. Supporting in vitro tests on food coloring stability, skin antioxidant repair and pet respiratory soothing were completed simultaneously. Global demand for immune dietary supplements surged in the post-pandemic era, making elderberry extract a mainstream natural immune raw material category.

3.2 2023 – 2024: Formation of Global Three-Tier Raw Material Regulatory Standard System

A unified three-tier classification of elderberry raw materials was established worldwide:

① Crude juice / syrup (total anthocyanins 1%–5%: mass-market beverages, ordinary syrups);

② Resin-enriched freeze-dried powder (total anthocyanins 10%–25%: health food, children's nutrition, pet care);

③ High-purity anthocyanin monomers (total anthocyanins ≥50%: high-end medical beauty repair, functional pigments, premium dietary supplements).

Formalities including FDA dietary supplement filing, EU EDQM herbal standards, Canadian natural health product catalog listing and Japanese food color additive registration were completed.

Supporting standards were simultaneously improved domestically: market access for fruit and vegetable beverage raw materials under GB/T 31121, safety assessment of cosmetic raw materials and toxicological limits of feed raw materials were fully updated, covering complete testing specifications for food, cosmetic and feed raw materials to form a full-track standardized management system. Domestic enterprises continuously advanced new food raw material registration to fill gaps in domestic edible regulatory standards.

4. Period of Independent Substitution of Domestic Processes and Maturity of Full Industrial Chain (2025 – 2026)

4.1 2025: Elderberry Anthocyanins Approved as New Food Raw Material, Domestic Production Lines Fully Benchmark Imported European and American Products

In November 2025, the National Health Commission officially announced the approval of elderberry anthocyanins as a new food raw material, specifying a daily intake cap of 3.2g, unsuitable populations and a full set of safety indicators. Domestic enterprises independently built complete closed low-temperature ultrasonic extraction production lines, remedying four major deficiencies including anthocyanin degradation, incomplete cyanogenic glycoside removal, extract discoloration tendency and unstable powder storage. Indicators of domestic products including total anthocyanin content, cyanogenic glycoside residues, solvent residues, microorganisms and light stability fully match imported European and American raw materials with significantly reduced comprehensive production costs. Full domestic substitution of mid-to-low-end standardized extracts has been realized, while domestic production of high-purity anthocyanin monomers gradually breaks import monopolies.

Over 50,000 mu of standardized contiguous Sambucus nigra planting bases have been built domestically, forming a complete closed-loop industrial chain:

Harvest ripe berries away from light and under temperature control → Closed low-temperature transportation within 4 hours → Sort and clean to remove branches, leaves and unripe fruits → Closed low-temperature ultrasonic extraction → Ceramic membrane removal of cyanogenic glycosides and pectin impurities → Directional anthocyanin enrichment via macroporous resin → Vacuum low-temperature concentration / freeze-drying → Microcapsule color-locking stable embedding → Aseptic storage away from light and low temperature.

4.2 2026: Comprehensive Iteration and Upgrade of Five Segmented Customized Products

Gradient layered products have taken shape across the industry: food-grade elderberry concentrated juice, low-irritation syrup specially for children, high-anthocyanin freeze-dried powder for health food, high-purity coloring anthocyanin monomers, antioxidant extract liquid for skincare, and pet immune premixes. Green low-temperature extraction technologies including ultrasound and solvent-free subcritical extraction have been widely adopted across the industry, drastically cutting organic solvent consumption and three-waste emissions. A supporting national standard method for simultaneous HPLC quantitative detection of dual anthocyanins has been unified nationwide, and acid-alkali resistant nano embedding technology solves stability pain points of anthocyanins under light and high temperature, adapting to full dosage forms including oral liquids, compressed candies, gummy candies, beverages, facial masks, wash care products and pet granules.

III. Commercial Development History

1. Stage of Self-Made Raw Berries and Trace Laboratory Extraction (4000 BC – 1984)

Indigenous peoples of Europe and North America only boiled fresh berries to make self-use syrups and juices. Laboratories in Europe and America only isolated trace amounts of anthocyanins for pharmacological and pigment research without standardized commercial extract raw materials. China had no large-scale Sambucus nigra cultivation or industrial extraction factories, with no formal elderberry extract commodities circulating in the domestic market.

Industrial characteristics: Absence of closed low-temperature extraction, membrane separation cyanogenic glycoside removal, resin anthocyanin enrichment and freeze-dried color stabilization technologies; lack of unified global quality control grading standards; a complete blank in the industrialization of standardized extracts.

2. Stage of Early European and American Industrialization, Full Reliance on Imported Raw Materials in China (1985 – 2018)

2.1 1985 – 1995: Small-Scale Standardized Raw Material Mass Production in Northern Europe and the United States

Low-temperature aqueous color-locking processes matured, with European and American enterprises launching influenza soothing syrups and oral drops for children. Global annual consumption of standardized extracts reached approximately 180 tons in 1995, with markets concentrated in European and American pharmacies and natural dietary supplement brands. China only carried out small-scale introduction trials without purification capacity, relying entirely on imports for standardized extracts required by health food and cosmetics.

2.2 1996 – 2018: Blank Domestic Industry, High Prices of Imported High-End Raw Materials

Enterprises in Northern Europe and the United States monopolized core purification technologies of low-temperature extraction and resin enrichment. Imported high-anthocyanin freeze-dried powder maintained high unit prices and was only supplied to high-end overseas dietary supplement and hospital skincare brands. Domestic enterprises lacked qualifications for compliant food-grade raw materials; only small volumes of crude juice were used in low-end beverages, failing to enter the health food track due to excessive cyanogenic glycosides and impurities.

Industrial characteristics: Overseas enterprises mastered full sets of core technologies for color-locking purification and safe detoxification; China lacked supporting systems for large-scale Sambucus nigra cultivation, industrial extraction and multi-index detection, with extremely low market awareness of graded standardized elderberry extracts.

3. Stage of Formed Domestic Production Capacity and Rapid Expansion of Five Application Tracks (2019 – 2024)

Global demand surged simultaneously for natural immune dietary supplements, clean-label natural pigments, functional children's nutrition, antioxidant skincare for sensitive skin and pet respiratory care, making elderberry extract an essential natural functional raw material. Global annual consumption of all-category raw materials exceeded 8,600 tons in 2024.

The five full application tracks were fully localized in China: immune-regulating health food, natural food color additives, children's respiratory soothing beverages, antioxidant repairing cosmetics and feed for pet immune care. Stable large-scale mass production of domestic standardized concentrated juice and mid-low anthocyanin content freeze-dried powder was realized in 2024, breaking the long-term technological monopoly of European and American manufacturers over basic raw materials. Domestic annual market consumption reached 2,700 tons, with 3,950 tons of standardized elderberry raw materials exported worldwide for the whole year.

A complete localized supporting industrial chain took shape, providing integrated technical services covering raw material testing, terminal formula compounding and dosage form development, fully covering all application scenarios of food, cosmetics, health food and feed.

4. Stage of Highly Mature Industry and Large-Scale Global Export of Domestic Raw Materials (2025 – 2026)

4.1 Clear Product Hierarchy, Precise Coverage of All Application Scenarios

The three-tier raw material gradient features clear positioning and differentiated competition: crude juice and syrup serve mass-market beverages and ordinary candies; resin-enriched freeze-dried powder targets children's nutrition, health food and pet care; high-purity anthocyanin monomers supply high-end coloring and medical beauty repair, fully covering both high-end and mass markets.

4.2 Mass Export of Domestic Raw Materials, Sustained Growth in Global Market Share

Domestic elderberry extracts match top European and American brands in anthocyanin stability and low-cyanogenic glycoside safety indicators. Supported by China's complete large-scale planting supply chain, customized low-temperature color-locking purification stabilization processes and cost advantages, domestic products are exported in bulk to the EU, North America, Southeast Asia, Japan, South Korea and Australia, continuously squeezing the supply share of traditional overseas raw material manufacturers.

4.3 Formation of Standardized Healthy Industrial Competition Pattern

Regulatory core frameworks include USP-NF, EU HMPC herbal monograph, China's new food raw material announcement and the Catalogue of Cosmetic Raw Materials Already in Use, setting access thresholds for safe cyanogenic glycoside limits of food-grade raw materials. Imported high-purity anthocyanin monomers are only supplied in small quantities to high-end special brands, while domestic graded standardized raw materials dominate domestic mass markets and emerging overseas markets. Industry competition has shifted from cutthroat low-price crude juice rivalry to comprehensive strength competition covering anthocyanin purity, customized cyanogenic glycoside removal, stability against light and high temperature, and supporting multi-country global compliance documentation.

4.4 Medium and Long-Term Industrial Development Trends (Post-2026)

- ***Full Popularization of Fully Closed Green Low-Temperature Production***

Large-scale promotion of ultrasound-assisted extraction, solvent-free subcritical low-temperature extraction, low-temperature impurity and cyanogenic glycoside removal via ceramic membrane, and biological enzymatic pectin removal technologies; full-process light shielding and temperature control eliminate degradation of heat and light-sensitive anthocyanins. Pomace by-products are recycled via fermentation to prepare composite polyphenol raw materials, realizing green full-berry circular production.

- ***Development of Special Graded Raw Materials Customized for Segmented Tracks***

Develop special graded raw materials with differentiated total anthocyanin content, cyanogenic glycoside residue, water solubility and acid-alkali resistance targeting five segmented tracks: immune health food, children's drops, clean-label coloring, sensitive skin repair cosmetics and pet respiratory care.

- ***Development of Pre-Compound Integrated Composite Raw Materials***

Develop immune pre-compounded raw materials blended with acerola cherry, echinacea, vitamin C and soothing polyphenol extracts to reduce secondary compounding procedures for terminal manufacturers and provide one-stop finished product formula solutions.

- ***Integrated Global Multi-Region Compliance Layout***

Complete filing and certification simultaneously for China's new food raw material, EU herbal raw material, US dietary supplement, Japanese food pigment and Canadian natural health product categories, unifying testing criteria and limit standards across multiple countries to achieve barrier-free cross-border circulation of elderberry raw materials globally.

● ***Continuous Iteration of High-Stability Delivery Technologies***

Nanoliposome and cyclodextrin composite microcapsule embedding technologies enhance oral bioavailability and transdermal absorption rate of anthocyanins; develop high-end dosage forms including sterile single-dose oral liquids, freeze-dried chewable tablets, sustained-release gummy candies and medical repair serums; advance suspension cell culture of Sambucus nigra to enrich anthocyanins, breaking supply restrictions of field planting seasons and land resources.

Conclusion

The elderberry extract industry originated from over 4,000 years of prehistoric European folk medicinal practice with berries, inherited through two millennia of ancient Greek-Roman classical medicine and medieval European pharmacopoeias, and has now evolved into a mainstream global standardized polyphenol functional raw material track covering five major fields: immune-regulating health food, natural food colorants, children's respiratory soothing beverages, antioxidant repairing cosmetics and pet immune care.

Its complete development cycle encompasses textual research on prehistoric herbal documents, isolation and identification of dual characteristic anthocyanin monomers, multi-center human clinical evidence-based verification of antiviral immunity, closed green low-temperature extraction, ceramic membrane cyanogenic glycoside and impurity removal, directional anthocyanin enrichment via macroporous resin, iterative freeze-dried microcapsule color stabilization technologies, and full independent technological catch-up by domestic manufacturers, completing full-chain industrial upgrading from wild fresh berries and crude high-temperature syrups to globally graded high-end functional anthocyanin raw materials.

Compared with traditional open high-temperature decoction and crude juice without cyanogenic glycoside removal, standardized low-temperature graded elderberry extracts adopt five core technologies: closed low-temperature ultrasonic extraction, ceramic membrane cyanogenic glycoside removal, macroporous resin anthocyanin enrichment, vacuum freeze-drying color locking and nano microcapsule light-shielded stabilization. They feature core competitive strengths including complete retention of anthocyanin activity, qualified removal of trace cyanogenic glycosides, stability against light and high temperature during storage, ultra-low organic solvent residues, adaptability to full dosage forms for food/cosmetics/feed, and compliance registration across multiple global regions, perfectly aligning with long-term global market trends of natural immune health, clean-label coloring, children's nutrition, sensitive skin care and pet wellness.

With continuous rollout of new technologies including solvent-free green extraction, customized raw materials for segmented tracks, nano-stabilized delivery and plant suspension cell culture in the future, elderberry extracts will permanently maintain a core position in raw material tracks of natural immune conditioning, natural edible pigments and antioxidant skincare, becoming an indispensable multi-functional mainstream berry plant raw material for health food, cosmetics, children's nutrition and pet industries.