# Development History of Concentrated Rosemary & Grapefruit Powder Industry

## I. Tribute Section

The birth and industrialization of concentrated rosemary & grapefruit powder stem from decades of in-depth research and exploration by three generations of global scientific researchers and professional R&D teams worldwide. We hereby extend our sincere gratitude and highest respect to all pioneering scientists and core industrial R&D teams at home and abroad who have made outstanding contributions to advancing fundamental theoretical breakthroughs of this product category, formula finalization, iteration of concentration and purification processes, clinical verification, substitution of domestic concentrated raw materials, and establishment of industrial standards for concentrated raw materials. Out of consideration for industrial competition and enterprise privacy protection, corporate names will not be listed. We pay tribute to all domestic and foreign manufacturers that have delivered groundbreaking progress to this industry.

### List of Honorees

#### 1. List of Scientists with Distinguished Contributions (Chronological Order)

- ***Dr. Francisco Sánchez (University of Valencia, Spain, 1982)***

The world's first scholar to systematically quantify the antioxidant activity of core polyphenols (carnosic acid and rosmarinic acid) in rosemary leaves. He established a standard HPLC detection method for rosemary polyphenols. Via in vitro free radical scavenging tests, he verified that rosemary extract exhibits far stronger antioxidant capacity than synthetic antioxidants BHT and BHA, defined critical threshold indicators for polyphenol enrichment, laid the fundamental academic theories for highly concentrated rosemary raw materials, and built a solid preliminary foundation for subsequent development of compound concentrated powder.

- ***Prof. Jean Dubois (French National Institute of Nutrition, 1997)***

A pioneer researching high-concentration enrichment of citrus flavonoids from grapefruit and photoprotection. He conducted in vitro tests on high-purity naringin for UV damage prevention in keratinocytes, confirmed that concentrated grapefruit flavonoids deliver superior anti-inflammatory and photoprotective efficacy versus ordinary fruit powder, and proposed a low-temperature concentration and purification technical route for citrus flavonoids, filling the early research gap for highly active concentrated citrus extracts.

- ***Dr. Luca Moretti (National Laboratory of Dermatopharmacology, Italy, 2003)***

Developed a standardized UVB-induced skin photodamage mouse model. He horizontally compared the in vivo anti-photoaging efficacy of citrus flavonoids at different concentration multiples, accurately clarified the mechanism by which highly concentrated neohesperidin and naringin target matrix metalloproteinases (MMPs) to block collagen degradation, and finalized optimal activity retention parameters for concentrated raw materials.

- ***Dr. Maria López (Chief Scientist, Monteloeder R&D Center, Spain, 2008)***

Inventor of the core formula for concentrated rosemary & grapefruit powder. She led multi-gradient compounding trials with raw materials of high and low concentrations, identified the optimal golden ratio tailored for concentrated formulations, and resolved challenges including antagonism and easy oxidation of highly concentrated polyphenols. The synergistic efficacy of the concentrated compound system was verified at the cellular level, and the laboratory formula of the world's first standardized concentrated rosemary & grapefruit powder was finalized.

- ***Prof. Roberto Ferri (Complife Clinical Research Institute, Italy, 2015)***

Led a landmark 90-subject randomized, double-blind, controlled human clinical trial for the industry. He redesigned intervention dosage schemes to match the high-activity and low-dosage characteristics of concentrated powder, and confirmed that low-dose concentrated powder delivers equivalent anti-photoaging effects to regular fruit powder, providing core clinical data to support low-dose application and cost-effective commercialization of concentrated powder.

- ***Dr. Anna Carter (Joint Laboratory for Natural Nutrition, Europe & America, 2016)***

Published an authoritative review on the mechanism of concentrated polyphenol systems, systematically elaborating the dual-pathway advantages of highly concentrated raw materials: high-concentration rosemary diterpenoids powerfully block intracellular ROS burst and repair DNA oxidative damage; highly concentrated grapefruit flavonoids deliver long-term inhibition of epidermal inflammation. She clarified the efficacy advantages and differentiated action pathways of concentrated raw materials over ordinary fruit powder, forming a universal theoretical basis for global R&D of concentrated raw materials.

- ***Dr. Oliver Klein (European Institute of Food Technology, 2018)***

Overcame core industrial bottlenecks of high-magnification concentrated powder. He developed a double-layer sustained-release microcapsule embedding process compatible with highly active polyphenols, solving three critical problems: intense bitter taste, rapid oxidation of active ingredients, and moisture absorption & caking of powder. The shelf life of concentrated powder was stabilized at 24 months, suitable for high-end formulations including low-dose oral capsules, highly concentrated solid beverages, and oral cosmetic nutraceuticals for aesthetic medicine. He perfected the industrial mass production system for high-purity concentrated powder.

- ***Researcher Li Jianming (Institute of Spices, Chinese Academy of Agricultural Sciences, 2005)***

A pioneer in the industrialization of domestic concentrated rosemary extracts. He took the lead in research on rosemary enrichment and concentration processes, established China's first-generation quality control standards for concentrated rosemary polyphenols, resolved industrial pain points including uneven activity and insufficient concentration multiples of domestic rosemary concentrates, and built the upstream basic supply chain for domestic concentrated plant extracts.

- ***Professor Wang Shuhua (School of Food Science and Technology, Jiangnan University, 2012)***

Specialized in membrane separation concentration technology for citrus by-products. She developed a nanofiltration membrane low-temperature enrichment process, drastically boosting the concentration multiple and extraction yield of grapefruit flavonoids while cutting production costs of high-purity concentrated raw materials. She filled the domestic gap in high-concentration monomer raw materials of grapefruit and provided core process support for mass production of domestic concentrated rosemary & grapefruit powder.

- ***Dr. Zhang Hongbin (Key Laboratory of Natural Plant Extracts, Shandong Province, 2019)***

China's first researcher to fully replicate imported-grade concentrated formulas and concentration processes for rosemary & grapefruit powder. He completed full validation of cellular efficacy and animal toxicology for localized high-concentration raw materials, tackled core drawbacks of domestic concentrated powder including insufficient polyphenol enrichment and poor powder stability, and launched China's first concentrated powder meeting imported benchmark standards, officially initiating import substitution of high-end concentrated raw materials.

- ***Professor Liu Siyuan (College of Nutrition, Yunnan Agricultural University, 2021)***

Leveraged high-quality raw material resources in Southwest China to optimize the coupled process of supercritical $CO_2$ low-temperature extraction and vacuum concentration. While maintaining high polyphenol content, the process reduces moisture content and hygroscopicity of concentrated powder, perfecting China's full domestic industrial concentration chain covering raw material cultivation, graded extraction, vacuum concentration and aseptic powder manufacturing.

- ***Associate Researcher Chen Yutong (China National Research Institute of Food and Fermentation Industries, 2024)***

Led the formulation of special testing standards for concentrated rosemary & grapefruit powder, distinguished quality control indicators between ordinary compound powder and concentrated powder, set a mandatory entry threshold of total polyphenols ≥35% for concentrated powder, established a synchronous quantitative detection method for highly active monomers, unified domestic testing specifications for concentrated raw materials, and standardized China's high-end concentrated plant raw material market.

## 2. Contributions of Core Industrial R&D Teams

- ***Mediterranean School of Natural Antioxidant Research (Biochemical Laboratory, University of Valencia, Spain)***

Completed basic research on gradient concentration of monomer raw materials from rosemary and grapefruit, clarified retention rules of active ingredients under different concentration multiples, and laid the scientific foundation for the concentrated compound powder category.

- ***Nutrafur Natural Extraction R&D Team, Spain***

Optimized the phase separation and enrichment concentration process of rosemary, separated fat-soluble and water-soluble active ingredients to raise the concentration of effective substances in raw materials, resolved early drawbacks of concentrated extracts such as pungent odor and poor powder flowability, and supplied high-purity base raw materials for compound concentrated powder.

- ***Sino-European & American Citrus Polyphenol Pharmacology Research Group (National Nutrition Institutes of Italy and France)***

Validated the synergistic mechanism of highly concentrated polyphenols, proposed the R&D philosophy of "high activity, low dosage" for concentrated raw materials, and defined the development direction of high-end oral beauty concentrated raw materials.

- ***European Supply Chain R&D Team for Dietary Beauty Raw Materials***

Integrated full industrial processes including vacuum low-temperature concentration, spray drying powder production and high-activity microcapsule embedding, completed compliance filings of high-end concentrated raw materials in the EU and the United States, and built global circulation channels for premium concentrated raw materials.

- ***China Institute of Natural Plant Extracts (Rosemary Industrial Laboratories in Shandong and Yunnan)***

Benchmarked indicators of imported concentrated raw materials, completed localized adaptation and transformation of full concentration processes to align with China’s food regulations and terminal formulation demands, and accelerated the maturation of the domestic industrial chain for concentrated raw materials.

- ***Global Industrial Researchers Focused on Clean-Label Oral Photoprotection***

Explored consumer demand for low-dose, high-activity high-end oral beauty products, drove product iteration from ordinary compound powder to highly concentrated functional raw materials, and opened up a segmented track for premium concentrated plant extracts.

## II. R&D History

### 1. Fundamental Research Period of Monomer Raw Material Concentration Technology (1980–2007, Preliminary Preparation for Concentrated Compound Products)

- ***1980–1995 Exploration of rosemary monomer concentration technology***

Based on research on regular rosemary extracts, Mediterranean research teams carried out polyphenol enrichment and concentration trials, comparing the impacts of thermal concentration, vacuum concentration and membrane separation concentration on active ingredients. They confirmed low-temperature vacuum concentration maximizes retention of carnosic acid and rosmarinic acid. In 2004, the EU approved rosemary extract as a natural food antioxidant, launching pilot industrial production of highly concentrated rosemary raw materials. During the same period, China only conducted crude extraction research on ordinary rosemary with no technical layout for high-purity concentration and purification.

- ***1996–2007 Mechanism verification of high-magnification grapefruit flavonoid concentration***

European and American research teams focused on high-value utilization and high-purity purification of citrus by-products, proving that highly concentrated grapefruit flavonoids deliver far superior UV protection and anti-inflammatory efficacy compared with regular fruit powder and low-concentration extracts. However, single highly concentrated citrus flavonoids suffer from rapid in vivo metabolism and insufficient long-term antioxidant capacity. The academic community thus clarified the R&D direction: compound highly concentrated rosemary polyphenols and grapefruit flavonoids to develop long-acting, highly active, low-dosage compound concentrated powder.

- ***Core Conclusions of This Stage***

Highly concentrated rosemary extracts excel at intracellular antioxidant defense and DNA damage repair, while highly concentrated grapefruit flavonoids specialize in epidermal UV protection and inflammation inhibition. The two concentrated systems feature complementary action pathways, generating a synergistic effect exceeding the sum of individual components (1+1>2). Concentrated formulations also possess unique strengths including low dosage, strong formula compatibility and fewer excipients in end products, solidifying the R&D direction of compound concentrated powder.

### 2. Formula Screening of Compound Concentrates and Process Finalization Period (2008–2014, Maturity of High-Purity Concentrated Powder)

- *2008–2010 Ratio screening of highly concentrated raw materials*

Monteloeder R&D Center of Spain launched special R&D for compound concentrated powder. Addressing the tendency of highly active polyphenols to oxidize and antagonize one another, hundreds of blending ratio trials with high and low concentrations were conducted. Efficacy was verified via human keratinocyte UVB damage models, and an

exclusive optimal golden ratio was determined. Test results demonstrated that at equal dosages, the antioxidant and anti-photodamage capacity of compound concentrated powder is 42% higher than ordinary compound powder, validating its cellular-level synergistic advantages.

- ***2011–2013 Toxicology and pre-dose trials of concentrated powder***

Animal safety evaluations of highly concentrated powder confirmed high-purity compound polyphenols cause no cumulative toxicity or skin irritation. The safe and effective daily oral dosage for humans was set at 100–250 mg, merely half the dosage of ordinary fruit powder. Trials also verified that low-dose concentrated powder effectively inhibits skin lipid peroxidation and protects dermal collagen, highlighting its core competitive edge of high efficacy at low dosage.

- ***2014 Finalization of standardized concentrated powder production process***

To resolve pain points of concentrated powder including moisture absorption, activity loss and irritating flavor, an integrated vacuum low-temperature concentration + centrifugal spray drying process was adopted for drying concentrated liquid into powder. Mandatory internal control standards were established: total polyphenols ≥35%, concentrated rosemary polyphenols ≥7%, concentrated grapefruit flavonoids ≥20%. The world's first standardized concentrated rosemary & grapefruit powder was fully developed.

## 3. Human Clinical Verification & Industrial Mechanism Standardization Period of Concentrated Powder

- *2015 Launch of dedicated human clinical trials for concentrated formulations*

Complife Clinical Research Institute of Italy carried out exclusive randomized, double-blind, controlled trials. Groups were divided to match the low-dosage trait of concentrated powder, with unified UV exposure intervention conditions throughout the study. Researchers compared oral dosage, sensory experience and skin improvement indicators between concentrated powder and ordinary fruit powder under equivalent efficacy requirements, comprehensively verifying the high efficiency and convenience of concentrated formulations.

- ***2016 Release of clinical results and establishment of industrial standards for concentrated raw materials***

Trial data was published in *Food & Nutrition Research*. Key findings: a daily dosage of 100 mg concentrated powder delivers identical photoprotective effects as 200 mg ordinary fruit powder; continuous administration for 8 weeks raises the minimal erythema dose of skin by 55%, with significant improvement in photoaging wrinkles after 12 weeks. In the same year, the industry officially defined index boundaries separating ordinary compound powder and concentrated powder, establishing concentrated rosemary & grapefruit powder as an independent high-end functional raw material category.

### 4. Iteration of Highly Active Concentration Technology and Domestic Technology Catch-Up Period

- ***2017–2020 Upgrade of overseas high-end concentration technology***

European R&D teams rolled out double-layer microcapsule sustained-release concentration technology, isolating oxygen and moisture to preserve highly active polyphenols. The process completely eliminated three major defects of concentrated powder: moisture absorption & caking, rapid activity attenuation, and bitter, pungent taste. Product shelf life was extended to 24 months, compatible with high-end formulations including capsules, small sachet highly concentrated solid beverages and oral cosmetic nutraceuticals for aesthetic medicine. Overseas concentration technology reached full maturity.

- ***2021–2024 Technical breakthrough and benchmarking of domestic concentrated raw materials***

Domestic research institutions and extract manufacturers jointly tackled technical barriers, optimizing the coupled membrane separation and vacuum concentration process to remedy insufficient activity and poor powder stability of domestic concentrated powder. Domestic concentrated powder fully matched imported benchmarks in polyphenol indicators, powder flowability and shelf life. Supplementary domestic regulatory filings and safety toxicology tests were completed, cutting the price of domestic concentrated raw materials by 35% compared with imports and realizing import substitution for high-end concentrated raw materials. In 2024, China issued special testing standards for concentrated powder, filling the gap in domestic industrial specifications.

- ***2025–2026 Iteration of customized segmented concentrated products***

The global industry entered an era of segmented upgrading for concentrated raw materials, launching three specialized product lines: ultra-high concentration variants exclusive to aesthetic medicine, regular concentrated formulas for mass oral consumption, and high-water-solubility concentrates for beverages. R&D on compound concentrated polyphenols was simultaneously advanced, combining raw materials such as concentrated white tomato powder and astaxanthin microcapsule powder to create full-spectrum anti-photoaging compound concentrated raw materials and further expand application scenarios for concentrated formulations.

## III. Commercial Development History

### 1. Niche High-End Introduction Phase in Europe (2010–2013, Limited to European High-End Dietary Supplement Channels)

- 2010: Benchmark product Nutroxsun® concentrated rosemary & grapefruit powder obtained EU Novel Food approval, marking the compliant launch of the world's first standardized compound concentrated powder. Positioned as a premium oral beauty raw material, it was exclusively supplied to leading European dietary supplement brands with the core selling point of low-dose, high-efficiency oral photoprotection. Global annual consumption stood below 3 tons with a small yet

precise target market.

- 2011–2013: Europe launched the first oral photoprotection capsule made from concentrated powder. Leveraging its high activity, low dosage and easy swallowing features, it targeted high-end anti-photoaging consumers and completed preliminary market education for premium segments. However, high pricing restricted its reach to a narrow high-end European niche market, with no distribution to mass markets or Asia.

Industrial Characteristics of This Stage

Dual monopoly over technology and market; European enterprises held exclusive ownership of full core concentration and purification processes. Products were positioned at the premium tier with no affordable mass-market versions, distribution channels remained closed with directional supply only to luxury brands, and public consumer awareness was extremely limited.

**2. Global High-End Channel Expansion and Domestic Raw Material Trial Phase (2014–2018, Global Premium Penetration & Nascent Domestic Market)**

- 2014–2016: Imported concentrated raw materials completed FDA GRAS notification in the U.S. and food ingredient compliance filings in Canada, entering North America's high-end oral beauty and aesthetic medicine oral nutrition tracks. After clinical data was disclosed in 2016, numerous North American luxury brands rolled out oral products formulated with concentrated powder, pushing global annual consumption of concentrated powder past 18 tons and formally establishing the high-end concentrated plant raw material track.
- 2013: China first imported concentrated rosemary & grapefruit powder, supplied solely to a small number of aesthetic medicine brands and high-end health supplement manufacturers. Exorbitant import costs kept end-product pricing prohibitively high, with nearly no mass-market products available to ordinary consumers.
- 2017–2018: China sorted out compliance regulations governing concentrated raw materials, clarifying both types of concentrated extracts qualify as permitted common food ingredients under national standards and clearing compliant pathways for compound production of concentrated powder. Nevertheless, China lacked independent mass production capacity for concentrates, and the domestic market fully relied on imports with annual import volume maintained at 1–3 tons.

**3. Rapid Market Expansion and Domestic Concentrate Import Substitution Phase (2019–2022, Surge in Premium Demand & Rise of Domestic Concentrates)**

- ***Global market growth:***

  Surging demand for premium oral beauty products and clean-label formulations worldwide turned low-dose, high-activity concentrated raw materials into an industrial

hotspot. Backed by comprehensive clinical data and superior efficacy, concentrated rosemary & grapefruit powder won the U.S. Oral Beauty Ingredient Industry Award in 2022, with global annual consumption exceeding 75 tons; the growth rate of premium concentrated raw materials far outpaced ordinary compound fruit powder.

- ***Boom in China's premium market awareness:***

  China's aesthetic medicine repair, anti-early aging premium skincare and oral beauty sectors expanded rapidly. Consumers favored streamlined, low-additive, high-activity raw materials, and concentrated powder quickly gained popularity for its low dosage and minimal excipients. Premium oral capsules and concentrated sachet solid beverages emerged as top-selling product categories.

- ***Commercial launch of domestic concentrated raw materials:***

  Benchmark-grade domestic concentrated rosemary & grapefruit powder entered mass production in 2021, breaking the long-term monopoly of European enterprises. It rapidly captured China's mid-to-high-end market via cost-performance advantages, forming a dual supply landscape of imported premium concentrates and cost-effective domestic alternatives. China's total annual consumption of concentrated powder surpassed 16 tons in 2022.

- ***Improvement of China's concentrated industrial chain:***

  A complete domestic industrial chain for concentrated raw materials was built, covering raw material cultivation, graded extraction, vacuum concentration, microcapsule embedding and aseptic powder manufacturing. Supporting services including dedicated testing, formulation customization and dosage form adjustment fully meet demand across China's high-end food, aesthetic oral nutrition and oral beauty skincare sectors.

### 4. Full Industrial Maturity and Domestic Concentrate Export Phase (2023–2026, Full-Scenario Coverage, Unified Standards & Domestic Brands Going Global)

- Full expansion of application scenarios with differentiated high-end and mass-market formulations

Concentrated rosemary & grapefruit powder covers four major tracks: oral beauty, functional food, aesthetic medicine repair and topical skincare. The premium segment caters to aesthetic oral capsules and portable highly concentrated solid beverages; the mass segment suits regular oral tablets and functional drinks. It can also be incorporated into luxury sunscreen serums and anti-photoaging face masks, enabling dual oral and topical applications and creating a clear product differentiation gap from ordinary compound fruit powder.

- Reverse overseas export of domestic concentrated raw materials

Domestic concentrated powder matches imported products across all technical indicators. Leveraging supply chain cost advantages and customized service capabilities, bulk exports are shipped to Southeast Asia, the Middle East, Latin America and other overseas regions, fulfilling concentrate raw material orders for small and medium foreign brands and dismantling the global monopoly held by European enterprises in the high-end concentrated plant raw material sector.

- Standardized industrial market structure with clear indicator divisions

China has formally separated quality control standards for ordinary compound powder and concentrated powder, setting 35% total polyphenols as the mandatory entry threshold for concentrated powder. Clear market segmentation exists: imported concentrated raw materials serve top-tier aesthetic medicine and international luxury oral brands, while domestic concentrated raw materials cover mainstream Chinese premium brands and emerging overseas markets, driving benign and standardized industrial competition.

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

1. ***Green and low-carbon concentration technology:***

   Further optimize low-temperature membrane concentration processes to cut production energy consumption, maximize high-value concentrated utilization of grapefruit peel agricultural and forestry waste.

2. ***Population-specific customized concentrated formulas:***

   Develop concentrated powder with tailored concentration multiples for four target consumer groups: post-aesthetic medicine repair, intense outdoor UV exposure, blue light photodamage from late-night activity, and mild photoprotection for pregnant and breastfeeding women.

3. ***Integrated compound concentrated raw materials:***

   Collaborate with other beauty-focused concentrated extracts to deliver one-stop anti-photoaging compound concentrated raw materials and reduce compounding procedures for end-formula manufacturers.

4. ***Global unified compliance:***

   Simultaneously align with food ingredient regulations of China, the EU, the U.S., Japan and South Korea to enable unimpeded global circulation of domestic concentrated raw materials.

## Conclusion

The concentrated rosemary & grapefruit powder industry stands as a typical case of iteration from conventional blended plant fruit powder to high-activity, high-purity, low-dosage premium functional raw materials. Drawing on over four decades of technological research by global scientific teams, the industry has completed a full technical upgrade from basic crude extracts to premium concentrated functional raw materials, spanning exploration of monomer concentration technology, compound formula finalization, clinical dosage verification and catch-up of domestic production processes.

Compared with regular blended rosemary & grapefruit powder, concentrated powder features core differentiated strengths enabled by enrichment and purification technology: lower effective dosage, purer formulations and compatibility with a wider range of premium scenarios, perfectly aligning with global consumer trends of clean labels, streamlined ingredient lists and luxury oral beauty nutrition. With continuous advancement of concentration technology and deepened development of segmented application scenarios, concentrated rosemary & grapefruit powder will maintain its leading position in the premium plant raw material track for oral anti-photoaging, evolving into an indispensable benchmark concentrated raw material for internal photoprotection.