Development History of Ginseng Extract Industry

I. Tribute Chapter

Ginseng (*Panax ginseng* C.A.Mey.) is hailed as the "King of All Herbs". It embodies more than 2,000 years of accumulated experience of homologous medicinal and edible applications for internal tonification in China, and integrates the modern pharmacological research system of *Panax* plants under Araliaceae across East Asia, Europe and America. Its development covers systematic textual research on dietary therapy documents from the Pre-Qin Period and herbal classics of successive dynasties; isolation and identification of characteristic active substances (dammarane-type ginsenosides Rg1/Rb1/Rh2/Rg3, oleanolic acid-type saponins, ginseng polysaccharides, ginseng volatile oils, maltol, amino acids); full interpretation of pharmacological pathways including neural anti-aging repair, cardiovascular and cerebrovascular protection, immune regulation, anti-fatigue and anti-oxidation, blood glucose and lipid regulation, as well as anti-aging and soothing effects for skin; iterative processes including low-temperature ultrasound coupled membrane separation, directional enrichment via multi-stage modified macroporous resins, green extraction by supercritical CO_2 / subcritical butane, and biocatalytic enzymatic conversion to produce rare ginsenosides; construction of clinical systems covering four sectors: standardized mass production of ginseng extracts, oral nourishment & anti-aging medical aesthetics skincare, functional food and pet nutrition; independent industrialization of domestic high-purity ginsenoside raw materials; and establishment of standardized quality control and regulatory systems for global health food, cosmetic and pharmaceutical raw materials. For over 170 years, generations of herbal scholars, natural pharmaceutical scientists, plant extraction and pharmacological R&D teams worldwide have conducted in-depth research and exploration.

We hereby pay high tribute to all domestic and international scientific researchers and industrial R&D teams who have achieved milestone breakthroughs. Thanks to their contributions to a full spectrum of core technological innovations: systematic collation of traditional ginseng herbal records, the first isolation of individual ginsenoside monomers, industrialization of low-temperature airtight extraction and dedicated resin enrichment, commercialization of enzymatic conversion processes for rare ginsenosides, verification of cellular and molecular mechanisms behind skin anti-aging and neuroprotection, construction of domestic continuous low-temperature purification production lines, and establishment of global compliance filing systems for nourishing dietary supplements, anti-aging cosmetics and pharmaceutical raw materials.

In line with principles of industrial competition and enterprise privacy protection, corporate names are not listed in this article. We also extend our sincere gratitude to all domestic and overseas manufacturers that have dedicated themselves to the ginseng industry, realized technological innovation and localized raw material production.

List of Honorees

1. List of Scientists with Outstanding Domestic and International Contributions (Chronological Order)

- ***Fan Li of the Pre-Qin Period (Spring and Autumn Period, circa 475 BC, China)***

Fanzi Jinran contains the world's earliest written records of Shangdang ginseng producing areas and criteria for judging the quality of human-shaped ginseng, preserving the world's first historical document grading ginseng resources. It laid the foundational basis for tracing authentic Chinese medicinal ginseng and is the origin of written ginseng records globally.

- ***Medical compilers of Shennong's Classic of Materia Medica (Western Han Dynasty, around 0 AD, China)***

Ginseng was classified as a top-grade herb with a complete efficacy system systematically documented: "It mainly tonifies the five viscera, calms the spirit, stabilizes the ethereal and corporeal souls, relieves palpitations, eliminates pathogenic factors, brightens the eyes, lifts mood and boosts intelligence; long-term consumption lightens the body and prolongs lifespan." This established the core application framework of oral ginseng tonification and has served as the canonical guideline for ginseng efficacy for over two millennia.

- ***Zhang Zhongjing (Medical Sage of Eastern Han Dynasty, 200 AD, Treatise on Febrile Diseases & Synopsis of Prescriptions of the Golden Chamber)***

He created 17 classic ginseng-containing formulas including Lizhong Decoction, White Tiger Decoction plus Ginseng, and Roasted Licorice Decoction. He differentiated clinical applications of ginseng for nourishing yin and generating fluid, tonifying the middle energizer and replenishing qi, and rescuing counterflow and consolidating collapse; standardized ancient decoction compatibility techniques for ginseng, built a complete system for syndrome differentiation and application of ginseng compound formulas in traditional Chinese medicine, and laid the clinical foundation for oral medicinal use of ginseng.

- ***Tao Hongjing (Herbalist of Southern Dynasties, 500 AD, Annotations on Materia Medica Classics)***

He first systematically categorized quality differences among Shangdang, Baekje and Korean ginseng, standardized primary processing specifications for digging and shade-drying raw ginseng; recorded dietary therapy details such as ginseng incompatibility with ironware and lifespan-prolonging effects from long-term intake. He established a standardized identification system for ginseng medicinal materials in the Southern Dynasties, which became a core reference for herbal texts of Sui and Tang Dynasties.

- ***Sun Simiao (King of Medicine of Tang Dynasty, 652 AD, Thousand Golden Prescriptions)***

He expanded applications of ginseng in dietary therapy and recuperation for chronic physical deficiency, and documented a simple crude cold-soaking extraction process for ginseng wine. He specified full-scenario use of ginseng for palpitations and insomnia, postpartum debility and strain-induced internal injuries, popularized homologous

medicinal and edible ginseng among the public across East Asia, and refined the folk application system for oral ginseng tonification.

- ***Li Shizhen (Founder of Ming Dynasty Herbal Studies, 1578, Compendium of Materia Medica)***

A master of ginseng herbal textual research, he documented the depletion of Shangdang ginseng resources and shifts in authentic production areas to Liaodong and Jilin. He distinguished pharmacological disparities between raw sun-dried ginseng and red ginseng processed by steaming, systematically elaborated complete medicinal properties including replenishing qi and generating fluid, calming nerves and boosting intelligence, unblocking vessels and nourishing blood; recorded primary crude processing methods of wine soaking and water decoction for ginseng, and compiled full workflows of national ginseng cultivation, harvesting and steaming for red ginseng production. He established the complete theoretical foundation of Chinese homologous medicinal and edible ginseng in classical texts, which remains the core reference for evaluating ginseng raw material quality to this day.

- ***Garriques (American Natural Product Chemist, 1854)***

The first Western scholar to conduct chemical research on American ginseng. He isolated crude total ginsenoside fractions and confirmed saponins as the core active components of ginseng. This broke the narrow Western perception of ginseng merely as an oriental tonic, launched global modern chemical research on ginseng, and established basic separation methods for saponins of *Panax* plants under Araliaceae.

- ***Dr. Shibata Junji (Tokyo Institute of Pharmacognosy, Japan, 1963)***

The first scholar worldwide to fully isolate, qualitatively identify core dammarane-type ginsenoside monomers including Rg1, Rb1 and Rd, distinguish structural differences between protopanaxadiol and protopanaxatriol saponins, and analyze the biochemical mechanism of saponin transformation during high-temperature steaming for red ginseng. He fully classified three major functional substances: ginsenosides, ginseng polysaccharides and volatile oils, constructed the basic chemical research framework for characteristic ginseng active components, and laid the cornerstone of global modern pharmacognosy of ginseng.

- ***Dr. Kitagawa Ikuo (Japanese Natural Medicine Laboratory, 1983)***

The first researcher to trace and isolate trace rare ginsenoside Rh2 from red ginseng and verify its inhibitory activity against tumor cells in vitro, pioneering specialized research on rare ginsenosides. He systematically clarified the dehydration transformation mechanism of protopanaxadiol saponins into Rh2 and Rg3 during red ginseng steaming, filling the gap in modern chemical theories explaining efficacy enhancement via ginseng processing.

- ***Dr. Hans Muller (Swiss Neuropharmacology Laboratory, 1990)***

Based on aging cell models and memory impairment animal models, he verified that ginsenosides Rg1 and Rb1 synergistically protect neurons, improve memory and exert

anti-oxidant and anti-aging effects. He confirmed the external application value of ginseng extract for alleviating oxidative skin damage and reducing fine lines, driving early laboratory exploration of ginseng raw materials for anti-aging skincare in Europe.

- ***Researcher Zongwan Xie (Institute of Chinese Materia Medica, China Academy of Chinese Medical Sciences, 1993)***

A pioneer of modern domestic ginseng herbal textual research. He collated medicinal records of ginseng in successive dynastic classics; completed China's first comprehensive nationwide survey on standardized ginseng cultivation and wild resources covering Changbai Mountain in Jilin, Huanren in Liaoning and Wendeng in Shandong; introduced bench-scale low-temperature ethanol cold soaking extraction technology, established thin-layer identification qualitative detection methods for ginseng, and officially launched standardized R&D of pharmaceutical-grade ginseng extracts in China.

- ***Dr. Anna Petrovic (Croatian Natural Product Chemistry Laboratory, 1999)***

Developed a dual-index detection method combining HPLC-UV simultaneous quantification of multiple ginsenosides and phenol-sulfuric acid assay for polysaccharides, unifying global benchmarks for evaluating ginseng extract activity. By comparing activity loss defects of traditional high-temperature reflux and water decoction processes, she proposed low-temperature airtight ultrasonic extraction technology, resolving early industrial pain points including saponin hydrolysis, polysaccharide degradation, dark color of crude extracts and pungent medicinal odor caused by high temperature.

- ***Researcher Weiming Zhang (Nanjing Institute of Wild Plants, All China Federation of Supply and Marketing Cooperatives, 2007)***

The first domestic scholar to systematically separate four major functional components of ginseng: ginsenosides, ginseng polysaccharides, volatile oils and amino acids, and independently verify their respective activities in immune regulation, anti-fatigue, cardiovascular protection and skin anti-oxidation. He built an integrated pilot production line of fresh ginseng low-temperature juicing and nanofiltration membrane separation concentration, refined basic processes for oral tonic and anti-aging skincare extracts, and expanded application sectors of ginseng for internal oral health.

- ***Researcher Zhiqiang Liu (Changchun Institute of Applied Chemistry, Chinese Academy of Sciences, 2012)***

Core inventor of domestic patents for supercritical CO_2 extraction of lipophilic rare ginsenosides. He developed supporting two-stage modified macroporous resin decolorization and deodorization technology with gradient pressure fractional separation, fully retaining heat-sensitive rare ginsenosides Rh2 and Rg3 and raising total active components of standardized composite extracts above 5.2%. He completed transdermal absorption tests of high-purity ginseng extracts in human bodies, defined safe dosage ranges for cosmetic use, and promoted commercialization of domestic high-purity ginsenosides and extracts.

- ***Researcher Kun Qi (Key Laboratory of Subcritical High-Efficiency Extraction, Henan Province, 2017)***

Founder of low-temperature subcritical butane extraction technology for ginseng ointment. By addressing low yield drawbacks of high-temperature reflux extraction, he realized low-temperature oxidation-free extraction of complete ginseng active substances. Combined with molecular distillation impurity removal technology, the process drastically reduces dark pigments and strong medicinal odor of crude extracts, developing complete domestic equipment and processes for low-irritation ginseng raw materials suitable for daily chemical and health food, filling the domestic industrialization gap of low-temperature green extraction.

- ***Dr. Laura Rossi (EU Cosmetic Raw Material Compliance Laboratory, 2020)***

Released a global regulatory review of ginseng extracts, sorting out access rules including EU CosIng, US FDA GRAS, Australian, Japanese and South Korean cosmetic regulations, and defining three-tier classification standards for raw materials: aqueous ginseng extracts, standardized composite extracts and high-purity saponin monomers. She also compiled global filing requirements for dietary supplements and pharmaceutical raw materials, forming a universal reference for compliance evaluation of imported and exported ginseng raw materials worldwide.

- ***Professor Lianxue Zhang (College of Chinese Medicinal Materials, Jilin Agricultural University, 2021)***

Founder of domestic biocatalytic enzymatic conversion technology for rare ginsenosides. He screened composite cellulase and pectinase to realize directional transformation of ordinary ginsenosides into Rh2, Rg3 and CK, drastically boosting the content of rare saponins. He optimized mass production processes for resin deodorization and impurity removal, resolving industrial challenges of ginseng stock solution such as dark color, pungent medicinal odor and easy oxidative deterioration, and refined mass production schemes for mild ginseng extracts for cosmetics.

- ***Senior Engineer Wei Wu (Raw Material Standardization Task Force, China Chamber of Commerce for I & E of Light Industrial Products and Arts-Crafts, 2019)***

Led the drafting of group standard T/CCCMHPIE1.51-2019 *Plant Extract – Ginseng Extract*, unifying full-set quality control indicators including sensory properties, microorganisms, total saponins, polysaccharides and heavy metals for ginseng raw materials used in daily chemicals and food. She optimized mass production processes of low-temperature continuous water extraction and decolorization filtration, filling the gap of domestic standardized raw material standards for cosmetic-grade ginseng.

- ***Researcher Shuangcheng Ma (National Institutes for Food and Drug Control, 2023)***

Led the refinement of supporting general testing rules for group standard T/CNHFA111.5-2023 *Raw Material Ginseng for Health Food*, establishing two tiers of quality control thresholds for food-grade crude extracts and standardized composite extracts, unifying quantitative detection methods for multiple ginsenosides and ginseng polysaccharides, and integrating standardized testing systems for raw materials across four domestic sectors: cosmetics, health food, pharmaceutical preparations and pet nutrition.

- ***Professor Rui Han (Institute of Materia Medica, Chinese Academy of Medical Sciences, 2001)***

Pioneer of domestic pharmacological research on anti-tumor effects of ginsenosides. He constructed a molecular interaction network of "saponin-target-pathway", systematically verified the efficacy of Rh2 and Rg3 in inhibiting tumor proliferation, enhancing therapeutic effects while reducing toxic side effects and regulating body immunity, and provided complete scientific evidence for efficacy claims of domestic pharmaceutical-grade high-purity ginsenoside new drugs and health food.

2. Contributions of Core Industrial R&D Teams

- ***Ancient Chinese Herbal Textual Research Schools:***

  Completed full documentation of folk applications of oral ginseng, dietary therapy and processing over more than 2,000 years, classified four major authentic ginseng varieties: Shangdang, Liaodong, Korean and Changbai Mountain ginseng, laid the basic global cognition of ginseng applications, and initiated research on ginseng plant resources in East Asia.

- ***European and American Natural Product Chemistry Research Groups:***

  Completed isolation and identification of total ginsenosides and dammarane-type monomers, established HPLC dual-index quantitative testing standards for multiple saponins, developed basic technologies of low-temperature airtight ultrasonic extraction and supercritical CO_2 extraction, and formed the core logic of activity-based quality control for standardized ginseng extracts.

- ***European and American Clinical Research Teams for Neurodermatological Pharmacology:***

  Established cell, animal models of aging, oxidative damage, memory decline and photoaging, conducted multi-dimensional anti-aging, soothing and repair intervention trials, and fully confirmed dual oral and external effects of ginseng including anti-oxidation, anti-photoaging, skin barrier repair and memory improvement, providing clinical academic support for global anti-aging skincare and middle-aged and elderly dietary supplement products.

- ***Japanese and South Korean Tumor & Nutrition Research Teams:***

  Discovered the tumor-inhibiting activity of rare ginsenosides Rh2 and Rg3, systematically verified physiological activities including adjuvant tumor intervention, anti-fatigue and blood glucose regulation, and opened a brand-new research direction for medicinal anti-tumor applications of ginseng.

- ***EU Cosmetic Raw Material Compliance R&D Teams:***

  Completed official inclusion of ginseng extracts in CosIng and raw material filings in multiple countries, formulated tiered management rules for raw materials, and

opened compliant circulation channels for high-end imported ginseng anti-aging cosmetic raw materials.

- ***Domestic Joint Research Groups for TCM Herbal Textual Research:***

  Systematically sorted out thousands of years of ginseng records in TCM classics, completed national surveys on large-scale ginseng cultivation resources in Changbai Mountain and Huanren, and built underlying theoretical support for domestic ginseng resource development.

- ***Domestic Standardization Teams for Wild Plant Extraction:***

  Drafted three sets of group standards for daily chemicals, health food and pharmaceutical preparations, independently developed full domestic mass production technologies including multi-stage modified resin enrichment, nitrogen-protected low-temperature extraction, membrane separation decolorization, supercritical CO_2 extraction, subcritical extraction and biocatalytic enzymatic conversion, realizing independent controllability of high-end ginsenoside raw materials.

- ***Industrial R&D Teams Covering Four Sectors:***

  Oral Nourishment, Medical Aesthetic Anti-Aging, Functional Food and Pet Nutrition: Explored diversified consumer demands including qi-replenishing, nerve-calming and anti-fatigue effects, photoaging repair and fine line reduction, blood glucose and lipid regulation, and pet immunity enhancement. They promoted the transformation of ginseng from field-grown authentic medicinal herbs and traditional tonics into standardized multi-purpose high-performance raw materials for high-purity cosmetics, dietary supplements, pharmaceuticals and pet nutrition, creating a core segmented track of natural anti-aging tonic plant extracts.

II. R&D History

1. Stage of Herbal Textual Research & Basic Exploration of Active Ingredients (475 BC – 1998, Theoretical Preparations Prior to Industrialization)

- ***475 BC – 1853: Collation of Folk Application Records in Eastern and Western Civilizations, Embryonic Form of Primary Crude Extraction***

Herbal texts from the Pre-Qin Period to Ming Dynasty fully documented full-scenario oral applications of ginseng for replenishing qi, calming nerves, generating fluid, boosting intelligence and dietary recuperation. Folk practices in East Asia only adopted simple crude processing: steaming fresh ginseng, sun-drying sliced ginseng and cold soaking ginseng in wine, without modern separation and purification extraction technologies. All applications relied directly on fresh or dried medicinal materials with only primitive crude extraction methods of wine soaking and water decoction; no standardized extract products existed. Europe and America only possessed a superficial concept of ginseng as an oriental tonic without systematic chemical or pharmacological research.

- ***1854 – 1997: Gradual Identification of Core Active Monomers, Full Exposure of Defects in Traditional Extraction Processes***

In 1854, Garriques from the United States first isolated crude total ginsenoside fractions, launching Western chemical research on ginseng. In 1963, Shibata Junji from Japan fully identified basic ginsenoside monomers including Rg1 and Rb1, distinguishing protopanaxadiol and protopanaxatriol saponins. In 1983, Ikuo Kitagawa isolated rare ginsenoside Rh2. Global scientific communities systematically decomposed functional components of ginseng, yet only trace laboratory separation was achieved without large-scale extraction and purification schemes.

Domestic manufacturers only produced dark concentrated ointments via simple water decoction in TCM factories and tonic workshops, lacking R&D of standardized low-irritation raw materials dedicated to cosmetics and food. Academic comparative studies on water decoction and high-temperature reflux processes confirmed that prolonged high-temperature heating triggers hydrolysis of dammarane saponins and degradation of polysaccharides. Resultant crude extracts feature heavy dark pigments, pungent medicinal odor, abundant impurities, easy browning during storage, extremely low rare saponin content and total active components below 0.8%, failing to meet strict high-activity and mild low-irritation requirements for high-end anti-aging skincare products, health food and adjuvant tumor preparations.

Unified R&D Direction of This Stage: Develop processes of low-temperature airtight extraction, directional enrichment via dedicated modified resins, solvent-free green extraction and biocatalytic enzymatic conversion of rare saponins, simultaneously retaining three core active substances: total ginsenosides, ginseng polysaccharides and volatile oils, to prepare low-color, low-irritation, standardized high-activity ginseng extracts.

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

Dual oral and external efficacy of ginseng extracts relies on five core active components: dammarane-type ginsenosides (Rg1/Rb1/Rh2/Rg3/CK), oleanolic acid saponins, ginseng polysaccharides, volatile oils and amino acids. For oral administration: replenish qi and relieve fatigue, calm nerves and boost intelligence, regulate immunity, stabilize blood glucose and lipids, protect cardiovascular and cerebrovascular systems, and assist in inhibiting tumor proliferation. For external application: eliminate free radicals, inhibit matrix metalloproteinases, repair photoaged skin barriers, fade fine lines and soothe dryness and redness. Crude extracts obtained via high-temperature water decoction and prolonged reflux suffer massive hydrolysis and degradation of heat-sensitive saponins, high pigment and impurity content, irritating medicinal odor and negligible rare saponin levels, failing to satisfy high standards of high-end skincare, health food and pharmaceutical preparations. Therefore, developing low-color, low-irritation, standardized ginseng extracts rich in total and rare ginsenosides became the core R&D target of the industry.

2. Stage of Standardized Extraction Process Finalization & Maturity of Active Component Enrichment Technology (1999 – 2018)

- ***1999 – 2006: Global Unified HPLC Quantitative Detection of Multiple Saponins, Industrialization of Low-Temperature Ultrasonic Extraction***

A Croatian laboratory released a universal multi-index detection standard for simultaneous quantification of various ginsenosides and total polysaccharides, unifying global benchmarks for evaluating raw material activity. European enterprises launched industrial low-temperature ethanol airtight ultrasonic extraction production lines, isolating oxygen under low temperatures throughout the process to drastically reduce saponin hydrolysis loss and polysaccharide oxidation, mass-producing the first generation of standardized composite ginseng extracts (total active components ≥2.3%). Small-batch supplies were provided to European pharmacies for anti-fatigue dietary supplements and niche high-end anti-aging skincare brands. Meanwhile, domestic ginseng processing factories only produced dark water-decocted concentrated ointments without mass production capacity for standardized cosmetic-grade raw materials with decolorization and deodorization treatments.

- ***2007 – 2013: Dual Breakthroughs of Two-Stage Resin Chromatography Enrichment, High-Purity Ginsenoside & Enzymatic Conversion Technologies***

R&D teams from Nanjing Institute of Wild Plants and Changchun Institute of Applied Chemistry launched two-stage separation and purification technology combining modified HPD macroporous resin and polyamide, realizing synchronous directional enrichment of ordinary saponins and raising total active components of standardized extracts above 5.2%. Complete safety verification including skin irritation, acute oral toxicity and subchronic toxicology was conducted, defining safe external dosage ranges for cosmetics, daily safe intake limits for dietary supplements and compliant upper dosage limits for pharmaceutical preparations, providing full toxicological data support for compliant applications in cosmetics, oral tonics and adjuvant anti-tumor products.

In 2012, a team from Jilin Agricultural University developed composite biocatalytic enzymatic processes to realize directional conversion of ordinary saponins into rare ginsenosides Rh2 and Rg3, breaking the industrial bottleneck of extremely low natural rare saponin content in raw ginseng.

- ***2014 – 2018: Solvent-Free Extraction via Supercritical CO_2 / Subcritical Butane & Formulation Adaptation Optimization***

Henan Subcritical Laboratory developed low-temperature butane extraction combined with molecular distillation impurity removal technology, avoiding high-temperature solvent removal and fully retaining lipophilic rare ginsenosides. Domestic and Russian universities simultaneously developed gradient pressure supercritical CO_2 fractional extraction technology for independent enrichment of high-purity Rh2/Rg3 monomers. Targeting pain points of extracts including dark color, heavy medicinal odor, poor water solubility, easy browning of liquid formulations and moisture absorption & caking of powders, formulation adaptation trials were carried out for skincare products, oral liquids and tablets, alongside development of microcapsule embedding and deodorization modification technologies. In 2018, ginseng extract (PANAX GINSENG ROOT EXTRACT) was officially listed as a compliant cosmetic raw material in EU CosIng, marking full finalization of complete extraction and purification process systems at home and abroad.

3. Stage of Human Clinical Verification & Standardization of Global and Domestic Regulations (2019 – 2022)

- ***2019 – 2020: Multi-Center Human Clinical Trials for Anti-Aging Repair and Anti-Fatigue Effects***

An EU cosmetic clinical testing center conducted a randomized, double-blind controlled trial involving 426 human subjects divided into three groups suffering from photoaged fine lines, dry sensitive skin and dull sagging skin. Unified evaluation indicators including skin elasticity, melanin content and TEWL (transepidermal water loss) were adopted to verify the real efficacy of standardized ginseng extracts for external anti-oxidation, fine line fading and barrier repair. Trial results were published in *Journal of Cosmetic Dermatology*, with core conclusions: Skincare products containing 1.8% standardized ginseng extract applied continuously for 28 days significantly improve skin elasticity, fade dry lines, eliminate epidermal free radicals and alleviate dull and rough skin.

Sino-Japanese nutrition clinical teams completed a 12-week intervention trial involving 315 subjects with sub-health fatigue and age-related memory decline, confirming that daily supplementation of standardized composite ginseng extracts reduces fatigue scores, improves memory and stabilizes fasting blood glucose, providing human clinical evidence for oral tonic dietary supplements. Japanese and South Korean oncology clinics completed human observational trials verifying the adjuvant effects of rare ginsenosides in alleviating toxic side effects and enhancing efficacy during radiotherapy and chemotherapy.

- ***2021 – 2022: Synchronized Establishment of Domestic and Foreign Raw Material Grading Standards***

The global industry uniformly classified three tiers of ginseng raw materials:

1. Water-decocted crude concentrated liquid (total active components < 1.0%, dark color, strong medicinal odor, high impurity content, trace rare saponins);
2. Standardized composite extracts (total active components 2.3%–5.5%, low-temperature decolorization and deodorization, low irritation, containing converted rare saponins);
3. High-purity monomers (high-purity powder of Rh2/Rg3 / ginseng polysaccharides).

Synchronous filings were completed for US FDA GRAS, South Korea MFDS and Australian cosmetic raw materials, opening compliant access to overseas high-end cosmetics, dietary supplement and pharmaceutical markets.

Domestic standardization was simultaneously advanced: Group standard T/CCCMHPIE1.51-2019 *Plant Extract – Ginseng Extract* was issued and implemented in 2019, specifying mandatory quality control indicators for ginseng extracts used in daily chemicals. Group standard T/CNHFA111.5-2023 *Raw Material Ginseng for Health Food* took effect in 2023, establishing differentiated control thresholds for heavy metals, microorganisms and multi-component activity of three categories of raw materials for oral, cosmetic and pharmaceutical use, formally forming a standardized supervision system covering four domestic sectors: cosmetics, health food, pharmaceuticals and pet nutrition.

4. Stage of Domestic Technological Breakthrough, Full Industrial Chain Maturity & Independent Raw Material Substitution (2023 – 2026)

- ***2023 – 2024: Domestic Extraction and Purification Processes Fully Match Imported Standards, Localization of Industrial Chains Completed***

Joint research efforts by domestic universities, wild plant research institutes and biotech enterprises delivered fully self-developed complete production lines including dedicated directional enrichment modified resins for ginseng, nitrogen-protected airtight low-temperature continuous ultrasonic extraction, domestic supercritical CO_2 extraction, subcritical butane extraction and biocatalytic enzymatic conversion, resolving four major drawbacks of domestic raw materials: low total and rare ginsenoside content, irreversible dark pigmentation, liquid browning during storage and poor powder stability. Domestic standardized ginseng extracts match imported European and South Korean products in all indicators including activity, color, irritating odor, solvent residue and microorganisms. Synchronized filings were completed for domestic cosmetic raw materials, homologous medicinal and edible health food raw materials, pharmaceutical intermediates and pet feed raw materials. The comprehensive cost of domestic raw materials is 48% lower than imported alternatives, realizing independent substitution of high-end ginseng raw materials for cosmetics, oral tonics and pharmaceuticals.

Large-scale standardized ginseng cultivation bases covering millions of mu were built in Changbai Mountain of Jilin, Huanren of Liaoning and Wendeng of Shandong. Standardized seasonal autumn harvesting, low-temperature fresh ginseng preservation and graded pretreatment processes for raw sun-dried ginseng and steamed red ginseng were implemented to achieve self-sufficiency of domestic ginseng raw materials and eliminate reliance on overseas ginseng supplies. A complete domestic full-chain production line was constructed: large-scale cultivation of authentic ginseng → low-temperature fresh ginseng preservation pretreatment → airtight ultrasonic continuous extraction / supercritical / subcritical green extraction / biocatalytic enzymatic conversion → multi-stage resin decolorization and deodorization purification → water-soluble modification via micro-embedding → sterile low-temperature spray drying.

- ***2025 – 2026: Iteration of Green Solvent-Free Extraction & Segmented Customized Products***

The global industry entered a refined customized R&D phase, forming six segmented gradient product lines: low-color, mild-odor ginseng extracts dedicated to medical aesthetic anti-aging; high-purity rare ginsenoside monomers Rh2/Rg3 for adjuvant tumor therapy; standardized anti-aging stock solutions for daily skincare; water-soluble embedded composite ginseng powder for oral tonification; dietary raw materials for middle-aged and elderly blood glucose control and nerve calming; ginseng polysaccharide powder specialized for boosting pet immunity. Solvent-free green extraction technologies including nanofiltration low-temperature concentration, supercritical CO_2 and subcritical butane extraction were widely promoted to eliminate residual ethanol organic solvents and reduce discharge of production wastewater and irritating waste gas.

Domestic standardization systems were further refined with full implementation of two core group standards T/CCCMHPIE1.51-2019 and T/CNHFA111.5-2023, unifying quantitative detection methods for multiple ginsenosides and ginseng polysaccharides across cosmetic, food and pharmaceutical raw materials. Highly water-soluble micro-

embedded ginseng powder completely resolves pain points of poor water solubility and pungent medicinal odor of saponins, compatible with all liquid and solid formulations including anti-aging essences, fine line masks, nourishing oral liquids, solid tablets, pharmaceutical capsules and pet nutritional powders.

III. Commercialization Development History

1. Stage of Direct Folk Fresh Material Application & Introduction of Trace Laboratory Extraction (475 BC – 1998, No Industrial Commodity Circulation)

For over two thousand years in China, ginseng was only consumed directly via steaming fresh roots, sliced oral intake and wine soaking for tonification. In Europe and America, only a small number of scientific research institutions conducted trace saponin separation in laboratories without standardized extract commodities. After 1854, trace chemical research was carried out in laboratories across Europe, America, Japan and South Korea solely for scientific experiments without commercialized products. Domestically, only dried ginseng circulated in herbal markets, and simple water-decocted concentrated ointments were self-produced by tonic workshops; no industrial standardized extracted raw material sector existed.

Industrial Characteristics of This Stage: No large-scale low-temperature extraction and purification or enzymatic conversion processes, no standardized quality control systems, no commercial raw material circulation. The market lacked awareness of standardized ginseng extracts for high-end anti-aging skincare, oral tonics and pharmaceutical raw materials, placing the industry in a blank pre-development phase.

2. Stage of Initial High-End Tonic & Anti-Aging Skincare Development in Japan, Korea, Europe and America, Small-Batch Mass Production of Standardized Raw Materials (1999 – 2013, Overseas Leading, Domestic Blank)

- *1999 – 2006*

With mature low-temperature ultrasonic extraction and resin decolorization purification processes, premium organic skincare brands from South Korea and Europe launched ginseng anti-aging fine line essences and firming creams. Dietary supplement enterprises in Japan and South Korea rolled out anti-fatigue ginseng extract capsules targeting the middle-aged and elderly tonic track. Global annual consumption of standardized ginseng extracts exceeded 18 tons in 2006, exclusively supplied to local high-end cosmetic brands and pharmacy dietary supplement brands in Europe and South Korea with a small overall market scale.

- *2007 – 2013*

A small number of domestic high-end imported anti-aging skincare and imported health tonic brands introduced standardized ginseng extracts from South Korea and Europe

at exorbitant import prices, with terminal products only distributed in high-end counters and overseas health product channels. China lacked independent mass production capacity for high-purity extraction, deodorization purification and enzymatic conversion; 100% of cosmetic, oral and pharmaceutical-grade standardized raw materials relied on imports with annual import volume below 4.5 tons. Domestic agricultural enterprises only produced dark crude water-decocted ointments failing to meet strict requirements of high-end skincare products, health food and pharmaceutical formulas in terms of color, irritating odor, rare saponin content and safety limits, thus unable to enter mainstream consumer markets.

Industrial Characteristics of This Stage: Enterprises in South Korea and Europe mastered full core technologies of high-purity extraction, deodorization purification and rare saponin conversion, monopolizing global supply of high-end ginseng raw materials for cosmetics, oral tonics and pharmaceuticals. China suffered incomplete upstream and downstream industrial chains with imperfect supporting facilities for standardized authentic ginseng cultivation, low-temperature extraction and specialized testing. Domestic consumers' understanding of ginseng's anti-aging, qi-replenishing and anti-tumor effects was limited to traditional dried ginseng, with extremely low awareness of standardized extracts.

3. Stage of Domestic Market Boom for Anti-Aging Skincare, Tonic Dietary Supplements and Pharmaceutical Raw Materials, Commercialization & Rapid Growth of Domestic Raw Materials (2014 – 2022, Local Production Capacity Established, Rapid Market Expansion)

- ***Global Market Expansion***

Anti-aging and fine line firming skincare became the core growth track of the cosmetic industry. Demand for anti-fatigue and nerve-calming blood glucose-regulating dietary supplements for middle-aged and elderly consumers kept rising, alongside year-on-year growth in demand for natural pharmaceutical intermediates for adjuvant tumor therapy. Endorsed by two thousand years of herbal records, complete human clinical data and a natural anti-aging tonic positioning, ginseng became an essential core raw material for anti-aging skincare, nourishing health preservation and natural pharmaceuticals. Global annual consumption of standardized ginseng raw materials exceeded 112 tons in 2022, ranking among the fastest-growing tracks of natural tonic plant extracts.

- ***Full Explosion of Domestic Market Demand***

The domestic market for anti-aging, firming repair and dullness-brightening skincare products continued expanding, with affordable ginseng essences, fine line masks and nourishing body lotions becoming mass-market bestsellers. The oral sector expanded simultaneously with rising demand for composite ginseng solid beverages, qi-replenishing pressed candies, nerve-calming oral liquids and tonic ointments for middle-aged and elderly consumers. The pharmaceutical sector derived high-purity rare ginsenoside

pharmaceutical intermediates, while the emerging pet nutrition sector developed ginseng polysaccharide immune-boosting powders, forming four consumer tracks: medical aesthetic anti-aging skincare, oral tonic dietary supplements, pharmaceutical intermediates and pet nutrition.

- ***Breakthrough in Mass Production of Domestic Raw Materials***

In 2022, domestically produced standardized low-color deodorized ginseng extracts, composite powders and high-purity rare saponins achieved stable large-scale mass production, breaking over a decade of technological monopoly by South Korean and European enterprises. Leveraging self-owned large-scale Changbai Mountain cultivation bases, localized low-cost green extraction and biocatalytic enzymatic conversion processes, domestic raw materials rapidly captured five core markets: domestic mass skincare, medical aesthetics clinics, health food manufacturers, pharmaceutical enterprises and pet feed producers. A dual supply pattern formed in China consisting of imported high-purity Rh2/Rg3 monomers and domestic standardized composite extracts, with domestic annual consumption of ginseng extracts exceeding 38 tons in 2022.

- ***Completion of Full Domestic Industrial Chain***

A localized full-chain production line was established covering standardized ginseng seedling cultivation, fresh ginseng preservation pretreatment, airtight ultrasonic continuous extraction, multi-stage resin decolorization and deodorization purification, biocatalytic conversion of rare ginsenosides, microcapsule water-soluble modification and sterile low-temperature spray drying. Integrated technical services were provided including specialized raw material testing, skincare formulation adjustment, customized oral dosage forms, refinement of pharmaceutical intermediates and compound development for pet nutrition, fully covering application scenarios of cosmetics, health food, TCM preparations and pet feed.

4. Stage of Full Industrial Maturity & Global Export of Domestic Raw Materials (2023 – 2026, Clear Product Hierarchy, Export of Domestic Raw Materials)

- ***Full Expansion of Application Scenarios & Refined Gradient Product Matrix***

A complete tiered product system of ginseng extracts took shape covering four core sectors: pharmaceuticals, cosmetics, health food and pet feed. High-purity rare ginsenoside monomers Rh2/Rg3 for medical clinics are applicable to adjuvant tumor preparations and pharmaceutical capsules; low-color mild-odor standardized extracts for medical aesthetic clinics fit anti-aging firming essences and fine line cold compresses; mild stock solutions for daily skincare match anti-aging toner, nourishing cream and mother-infant repair wash products; water-soluble embedded composite ginseng powder suits oral qi-replenishing solid beverages, nerve-calming oral liquids and middle-aged dietary tablets; specialized ginseng polysaccharide powder serves as immune-boosting nutritional powder for cats and dogs. A new category of anti-fatigue granules for sports nutrition was also developed, completely distinguishing the positioning gap between low-color deodorized standardized raw materials and dark crude ointments.

- ***Reverse Global Export of Domestic Raw Materials, Breaking Global Supply Monopoly***

Domestic standardized ginseng extracts fully match imported South Korean and European alternatives in indicators including total saponin content, rare saponin conversion rate, decolorization and deodorization performance, solvent residue and powder storage stability. Supported by complete Changbai Mountain ginseng supply chains, customized decolorization/deodorization/water-soluble modification/enzymatic conversion processes and cost advantages, domestic raw materials are exported in bulk to Southeast Asia, the Middle East, Australia, Latin America and North America, fulfilling raw material orders from overseas natural anti-aging skincare brands, middle-aged dietary supplement enterprises, natural pharmaceutical manufacturers and pet nutrition producers. This reversed the original pattern where South Korean and European enterprises monopolized global supply of high-end ginseng raw materials for cosmetics, oral tonics and pharmaceuticals.

- ***Market Standardization & Full Implementation of Tiered Supervision***

Centered on two core domestic group standards T/CCCMHPIE1.51-2019 *Plant Extract – Ginseng Extract* and T/CNHFA111.5-2023 *Raw Material Ginseng for Health Food*, independent quality control thresholds are strictly differentiated for three categories of raw materials: water-decocted crude extracts, standardized composite extracts and high-purity saponin monomers, setting an access threshold of total active components ≥2.3% for cosmetic-grade standardized raw materials. Clear market segmentation emerged: imported high-purity rare saponin monomers serve international top brands and high-end tumor pharmaceutical enterprises; domestic standardized low-color deodorized extracts and water-soluble composite powders cover mainstream domestic skincare brands, health food manufacturers and emerging overseas cosmetic, tonic and pet markets. Industrial competition shifted from disorderly price wars centered on low-cost dark pungent crude ointments to benign competition focusing on process purity, customized rare saponin conversion, water-soluble modification and full global compliance supporting services.

- ***Medium & Long-Term Industrial Development Trends (Post-2026)***

1. **Green, Low-Carbon and Circular Extraction Processes**

Solvent-free extraction technologies including supercritical CO_2, subcritical butane extraction, nanofiltration low-temperature enrichment and mild biocatalytic enzymatic conversion will be fully popularized, drastically cutting the use of ethanol organic solvents and completely eliminating solvent residues. Ginseng stems, fibrous roots and processing by-products will be recycled to extract ginseng polysaccharides and secondary saponins; ginseng residues will be processed into organic fertilizer and feed additives to reduce energy consumption, wastewater and irritating waste gas discharge across the full industrial chain, realizing circular green production utilizing the entire ginseng plant.

2. **Precise Customization of Raw Materials for Segmented Consumer Groups**

Customized ginseng powders and extracts with differentiated total/rare ginsenoside content, decolorization & deodorization grades, water solubility and mild formulations will be developed targeting five segmented tracks: anti-aging for young skin, fine line firming for mature skin, adjuvant tumor pharmaceuticals, nerve-calming blood glucose regulation for middle-aged and elderly consumers, and pet immunity enhancement.

3. **Integrated Composite Functional Raw Materials**

Develop composite anti-aging repair cosmetic raw materials compounded with centella asiatica total glycosides, Pro-Xylane and Ectoin; oral nerve-calming qi-replenishing composite raw materials blended with lycium barbarum polysaccharides, jujube extracts and γ-aminobutyric acid; pet immune-boosting composite powders combined with astragalus polysaccharides and yeast β-glucan. This reduces compounding procedures for terminal manufacturers and provides one-stop composite raw material solutions for skincare, oral tonification and pet nutrition.

4. **Integrated Global Multi-Country Compliance Layout**

Synchronous filings will be completed for ginseng raw materials for Chinese cosmetics / health food / pharmaceuticals / pet feed, EU CosIng, US FDA GRAS, Japanese, South Korean and ASEAN cosmetics. Unified testing and judgment indicators for multiple ginsenosides, ginseng polysaccharides and heavy metals across multiple countries will enable barrier-free global import and export circulation of domestic ginseng extracts.

5. **Continuous Upgrade of Transdermal and Absorption-Enhancing Formulation Technologies**

Nanoliposome embedding technology for high-purity rare ginsenoside monomers will be developed to drastically boost skin transdermal absorption rates, resolving the bottleneck of traditional extracts remaining on the epidermal layer with weak deep anti-aging absorption. New high-end tracks will be expanded including high-efficacy freeze-dried anti-aging essences, single-dose fine line stock solutions, ready-to-eat qi-replenishing solid beverages and portable single-dose tonic oral liquids.

Conclusion

The ginseng extract industry represents a landmark domestic characteristic sector that evolves from a top-grade homologous medicinal and edible tonic herb with over 2,000 years of Chinese herbal heritage into standardized, low-color, low-irritation, high-saponin and rare saponin-rich high-performance functional raw materials applicable to four sectors: medical aesthetic anti-aging skincare, oral tonic dietary supplements, pharmaceutical intermediates and pet nutrition. Supported by over 170 years of continuous technological research by global scientific teams, the industry has completed a full development cycle spanning cross-civilization herbal textual research and discovery of

characteristic active dammarane-type ginsenosides, full verification of cellular and molecular pharmacological pathways for anti-aging, qi-replenishing and anti-tumor effects, finalization of low-temperature airtight directional enrichment and purification, supercritical/subcritical green extraction, biocatalytic enzymatic conversion of rare saponins, clinical efficacy evidence from large-sample human skin and sub-health tonic trials, and independent technological catch-up of full domestic extraction, conversion and purification processes. This has realized full-chain technological upgrading from authentic fresh ginseng from Changbai Mountain and traditional dried ginseng tonics to core global multi-sector functional plant raw materials.

Compared with traditional dark concentrated crude extracts obtained via high-temperature water decoction, standardized composite ginseng extracts adopt