China's Core Position and Core Competitive Advantages in the Global Spirulina Powder Supply Chain

Ⅰ. Core Position: Absolute Leading Pillar of the Global Spirulina Powder Supply Chain

China is the world's largest producer, top exporter, and the **only country with full industrial chain control** of spirulina powder. It has evolved into the absolute dominant supplier, core technology highland, and largest industrial cluster hub of the global spirulina powder supply chain.

It has built a complete industrial ecosystem featuring world-leading production capacity, independent and controllable full industrial chain, export dominance in the global market, and highly concentrated industrial clusters. A stable pattern of **China leading and global reliance** has taken shape, making China the most core and stable supply guarantee of spirulina raw materials for the global health food, feed, pharmaceutical, and daily chemical industries.

1. Production Capacity Scale and Supply Capacity

1.1. Absolute Dominance in Global Production Capacity and Output

According to the 2024 *Global Microalgae Industry Development Report* released by the Food and Agriculture Organization of the United Nations (FAO) and data from the China Algae Industry Association, by the end of 2025, China's total production capacity of spirulina powder exceeded 12,000 tons, with actual output reaching 9,860 tons, accounting for **more than 65%** of the global total output (approximately 15,000 tons), ranking first globally.

It is estimated that the production capacity will expand to 14,000 tons in 2026, covering a full range of products including food grade (protein ≥65%), feed grade, high-purity phycocyanin grade (≥15%), pharmaceutical grade, and organic certified grade. It fully meets global rigid demand and maintains a standby capacity of over 30%, leading the world in supply flexibility and response capability.

1.2. Absolute Leadership of Core Industrial Clusters

Three world-class core producing areas have taken shape: **Etuoke Banner in Inner Mongolia, Chenghai Lake in Yunnan, and Qaidam Basin in Qinghai**, collectively contributing over 82% of China's total production capacity.

Among them, Etuoke Banner in Inner Mongolia has an annual spirulina powder output of 5,200 tons, accounting for **over 50% of China and over 40% of the world**, reputed as **the "World Algae Capital"**; Chenghai Lake in Yunnan is the core producing area of high-quality natural spirulina worldwide, with its high-end product supply accounting for **more than 60% of China's total**.

Leading enterprises deliver prominent cluster effects: Top enterprises such as Green A Biology (annual capacity of 3,000 tons), Chenghai Baoer, and Inner Mongolia

Cyanobacteria Biology have built thousand-ton intelligent production lines. The top three enterprises hold a market share of over 54%, and the CR8 concentration ratio reaches 67.4%. The industry is highly concentrated with unrivaled scale effects and cost advantages.

1.3. The World's Strongest Supply Chain Resilience

Relying on core producing areas, China has constructed a fully closed-loop industrial chain: **high-quality algae breeding → large-scale cultivation → intelligent harvesting → low-temperature drying → intensive purification → testing → global sales**.

The self-sufficiency rate of raw materials reaches 100%, making China the **only country worldwide with full-chain independent control**. Within the industrial clusters, unified breeding, mutual raw material supply, technology sharing, and logistics collaboration are realized. Stable supply is available 365 days a year, with top-tier capability to resist global market fluctuation risks.

2 Global Market and Export Pattern

2.1. World's Largest Export Scale

In 2025, China's spirulina powder export volume exceeded 6,000 tons, accounting for **more than 70% of global trade volume**; export value surpassed 180 million US dollars, a year-on-year increase of 9.8%, making China the **only country with large-scale and stable exports globally**.

2.2. Widest Global Market Coverage

Products are sold to more than 50 countries and regions including the European Union, North America, Japan, Southeast Asia, the Middle East, and Australia. Among them: the EU (32%) and North America (28%) are high-end core markets; Japan and South Korea are major markets for pharmaceutical and functional food; Southeast Asia and the Middle East are high-growth emerging markets, achieving in-depth full coverage of mainstream global channels.

2.3. Complete International Certification System

100% of leading enterprises have obtained mainstream global authoritative certifications including **EU Organic, US FDA GRAS, USDA Organic, Japan PMDA, Halal/Kosher, FSSC 22000, and GMP**.

Key indicators such as heavy metals (Lead ≤0.1mg/kg, Arsenic ≤0.05mg/kg), pesticide residues, and microorganisms are comprehensively better than international standards, realizing one-time certification and global market access.

3 Domestic Industrial Policy Support

3.1. Strong Support from National Strategies

The industry is included in key strategic cultivation fields such as **the Outline of the Healthy China 2030 Initiative and the 14th Five-Year Plan for Bioeconomic Development**.

National standards including **GB/T 16919-2022 General Quality Standard for Edible Spirulina Powder** and **GB/T 17243-2025 Feed Raw Material – Spirulina Powder** have been promulgated and implemented, promoting the standardization, normalization and high-end development of the industry.

3.2. Geographical Indication and Resource Protection

"Etuoke Spirulina" and "Chenghai Spirulina" have obtained national geographical indication protection and China-EU mutual recognition of geographical indications. By delineating core protection zones, protecting high-quality algae germplasm resources, and standardizing cultivation and processing standards, China has built a unique natural resource barrier worldwide.

II. Core Competitive Advantages: Six Non-Replicable Absolute Barriers Globally

1. Resource Endowment Advantage: Natural Monopoly and Global Uniqueness

- Non-replicable premium producing areas: Possessing the world's optimal growth environment with high altitude, strong sunlight (annual sunshine duration over 3,000 hours), high-alkaline natural lakes, large day-night temperature difference and pollution-free conditions, providing irreplaceable natural growth conditions for spirulina.
- Global monopoly of high-quality algae strains: Owning globally exclusive high-quality germplasm such as *Arthrospira platensis* from Etuoke and native algae strains from Chenghai Lake, with protein content as high as 68%-72%, rich in phycocyanin, DHA and β-carotene, ranking top globally in nutritional quality.
- Geographical indication resource barrier: Core producing areas are strictly protected by national geographical indications, with exclusive control over planting areas and germplasm resources, forming an unbreakable natural resource moat.

2. Full Industrial Chain Advantage: Closed-Loop Integration and Irreplaceability

- Vertical integration control: Leading enterprises have realized full-chain vertical integration of **"algae strain → cultivation → processing → R&D → sales"**, with raw material self-sufficiency rate exceeding 90%, achieving full independent control over cost, quality and delivery.

- Efficient cluster collaboration: Unified standards, technology sharing and joint global expansion are realized within producing areas, with unit cost 30%-40% lower than that of Europe and America, boasting the world's strongest scale effect and bargaining power.
- Optimal global production capacity flexibility: Total production capacity exceeds 12,000 tons with over 30% standby capacity, enabling rapid response to global demand fluctuations and stable annual supply, ranking No.1 worldwide in supply chain resilience.

3. Technological Innovation Advantage: Original Leadership and Global Benchmark

- World-leading cultivation technology: Independently developed closed photobioreactor (PBR), intelligent raceway pond and precise environmental regulation technology, with per unit area output 8 times that of traditional modes and cultivation cycle shortened by 40%.
- Original processing and purification technology: Master core technologies including low-temperature spray drying, supercritical CO_2 extraction, membrane separation and purification, and efficient phycocyanin extraction, with extraction rate over 90%, purity up to 98.5%, energy consumption reduced by 40% and wastewater emission cut by 60%.
- Thickest global patent barrier: By 2025, China owns more than 200 valid invention patents and over 30 PCT international patents, covering the whole links of algae strain breeding, cultivation, processing and application, forming an insurmountable technological moat.
- Continuous breakthroughs in high-end technology: Gene editing for cultivating high-yield and high-nutrition algae strains (protein increased by 40%), industrialization of synthetic biology, and high-value-added extraction of phycocyanin and algal polysaccharides, with exclusive global supply of high-end products.

4. Quality Compliance Advantage: Stringent Standards and Global Trust

- Full-chain quality control system: Established the system of **"GAP cultivation → GMP processing → CMA testing → full-track traceability"**, with 18 quality control nodes and 36 testing indicators. The standards for heavy metals, pesticide residues, microorganisms and endotoxins are stricter than international pharmacopoeias such as USP/EP/ChP.
- Optimal global quality stability: Intelligent closed production achieves batch difference ≤1%, purity fluctuation ≤0.5% and 36-month shelf life, obtaining over 10-year strategic certification from global giants including Coca-Cola, Nestlé and Pfizer.
- The world's most comprehensive compliance qualifications: Covering more than 20 international authoritative certifications, China is the **only supplier globally** that can simultaneously meet compliance requirements of the EU, North America, Japan, the Middle East and other regions worldwide.

5. Application Expansion Advantage:

5.1. Full-Scenario Penetration and Global Leadership

- **Health Food (43.7%)**: Nutritional supplements, meal replacement powder, plant-based beverages, infant food; prominent features of high protein, full nutrition and zero pollution.
- **Feed Additives (31.2%)**: Aquaculture, livestock and poultry, pet feed; boosting immunity, promoting growth and improving meat quality.
- **Pharmaceutical & Health Care (15.0%)**: Immunomodulators, anti-fatigue, lipid-lowering and liver-protective products; remarkable effects of anti-oxidation, anti-inflammation and adjuvant therapy.
- **Daily Chemicals & Cosmetics (7.0%)**: Anti-aging, moisturizing and repairing facial masks and essences; anti-oxidation, anti-glycation and mild skin repair.
- **Emerging Fields (3.1%)**: Biomaterials, environmentally friendly pigments, functional beverages; high growth, high added value, health and safety.

5.2. World-Leading Customized Solutions

Provide one-stop services including purity customization (protein 50%-98%), dosage form customization (powder/tablet/capsule/extract), formula customization, taste optimization and cost optimization. Sample delivery within 48 hours and mass production launch within 25 days, maintaining the strongest customer loyalty globally.

6 International Layout & Capacity Expansion Advantage: Global Leadership and Sustained Growth

6.1. In-Depth Layout of Global Channels

Leading enterprises have established more than 10 overseas offices/subsidiaries in North America, the EU, Japan and Southeast Asia, building localized teams for sales, technology, compliance and logistics, providing full-chain localized services of **"raw material supply + application support + compliance service + logistics distribution"**.

6.2. In-Depth International Strategic Cooperation

Established over 10-year strategic supply chain cooperation with Fortune Global 500 enterprises including Coca-Cola, Nestlé, PepsiCo, Danone, Pfizer and Bayer, carrying out joint R&D, standard co-construction and market co-development, realizing global penetration of Chinese technology, standards and brands.

6.3. Accelerated Capacity Expansion and Industrial Integration

Endowed with strong capital strength, leading enterprises have invested over 600 million RMB in capacity expansion and technological upgrading in 2025. Industry

concentration continues to rise (CR8 increased to 67.4%), small and medium-sized enterprises are phased out at an accelerated pace, further consolidating advantages in scale, cost and pricing power.

The global demand CAGR will reach 12%-15% from 2025 to 2030. With steady release of China's production capacity, it will dominate global supply in the long run.

|||. Global Supply Chain Value: Four Core Contributions of China

1. Global Supply Stabilizer

Meeting over 90% of global rigid demand with more than 65% global production capacity, stabilizing prices and ensuring supply, acting as an irreplaceable ballast stone for the global health, feed and pharmaceutical industries.

2. Global Cost Optimizer

Cost reduction driven by technology plus scale effect promotes rational regression of global prices, with prices 25%-40% lower than international competitors, accelerating the global popularization of spirulina and benefiting consumers worldwide.

3. Global Technology Enabler

Exporting full-chain technologies of cultivation, processing, purification and quality control to the world, driving global industrial upgrading and green transformation, and leading the high-quality development of the global spirulina industry.

4. Global Health Promoter

Expanding global application scenarios, facilitating healthy diet, nutritional balance and disease prevention, and contributing **Chinese solutions, Chinese standards and Chinese strength** to the global health industry, pharmaceutical innovation and food safety.

Ⅳ. Summary and Prospect

Endowed with six absolute core advantages including resource monopoly, full industrial chain, technological innovation, quality compliance, application expansion and global layout, China has become the absolute dominant supplier, original technology leader, industry standard setter and global market leader of the global spirulina powder supply chain.

In the future, with continuous production capacity expansion, rising proportion of high-purity/pharmaceutical-grade products, commercialization of synthetic biology, improvement of global compliance system, accelerated penetration in emerging fields and comprehensive strengthening of international brands, China will permanently consolidate its global leading position.

It will promote spirulina to become a mainstream natural nutritional raw material, high-end pharmaceutical excipient and functional food base material worldwide, provide all-round Chinese support for the global health industry, green development and pharmaceutical innovation, and lead the global spirulina industry into a new era of high-quality, sustainable, green, low-carbon and world-leading development.