Classic Case Analysis of Application Fields of Spirulina Powder

Overview

Spirulina Powder is a natural microalgal nutritional raw material refined from *Arthrospira platensis* or *Arthrospira maxima* of the Oscillatoriaceae family in Cyanophyta through cultivation, harvesting, washing, spray drying and ultrafine grinding. Its core active ingredients include phycocyanin, spirulina polysaccharides, **γ-linolenic acid**, **β-carotene**, complete protein, as well as mineral elements such as iron, selenium and zinc.

Its core physicochemical properties feature **high protein (65%~72%)**, high nutritional density, natural dark green color, good water solubility, moderate thermal stability and a wide pH tolerance range (stable at pH 4~9). The protein content on a dry basis is far higher than traditional animal and plant protein sources, with a balanced amino acid composition and essential amino acids accounting for over 45%. It is jointly recognized by the **Food and Agriculture Organization of the United Nations (FAO)** and the **World Health Organization (WHO)** as *"the most ideal nutrient source of the 21st century"*.

Its core advantages cover complete high-quality protein, zero cholesterol, low fat, zero trans fat, high dietary fiber, natural antioxidant activity, immune regulation, anti-radiation effect, heavy metal chelation, iron supplementation and blood nourishment, blood lipid regulation, clean label compatibility and medicinal-food homology. It maintains stable activity in scenarios such as low-temperature baking, acidic beverages, neutral staple foods, high-temperature sterilization and feed processing, meeting nutritional supplementation and health improvement demands for all age groups.

It effectively solves common industry pain points of traditional protein sources: high calorie, high cholesterol, low digestibility and absorption rate, single synthetic nutrients, unbalanced amino acids in plant protein, and shortage of animal protein resources. With multiple functions including nutritional fortification, immune activation, flavor and color regulation, texture improvement, antioxidant color protection and clean label adaptation, spirulina powder spans seven core sectors: nutritional staple foods, sugar-free beverages, fermented dairy products, baked pastries, functional health supplements, aquatic and livestock feed, as well as pharmaceutical and daily chemical products, forming world-class commercial applications.

Selected classic cases from global leading brands and authoritative institutions in seven core tracks—nutritionally fortified staple foods, natural sugar-free beverages, fermented dairy products, healthy baked goods, functional nutritional tablets, high-grade aquatic feed, and special medical rehabilitation foods—are analyzed professionally and in depth from seven dimensions: **market pain points - product positioning - formula design and highlights - functional efficacy - regulations and claims - commercial value - market performance**. This provides authoritative and implementable reference templates for enterprises in nutritional upgrading, protein substitution, clean label application, health innovation, cost reduction and efficiency improvement.

I. Nutritionally Fortified Staple Foods: Complete Protein, Benchmark for National Nutritional Staple Food Development

Case 1: COFCO Grain · Spirulina Nutritional Noodles (Benchmark for China's Staple Food Fortification)

1. Market Pain Points

Traditional wheat staple foods only contain 10%~12% protein, lacking lysine and threonine with single nutrition. They are restricted for people with hyperglycemia and hyperlipidemia; the middle-aged, elderly and children are prone to insufficient protein and iron deficiency anemia. Ordinary nutritionally fortified noodles rely on synthetic vitamins and minerals with low absorption rates and poor flavor. The industry is in urgent need of high-end nutritional fortification solutions with natural sources, complete nutrition, high protein, iron and selenium supplementation, compatibility with staple food processing technology and no deterioration in taste.

2. Product Positioning

A benchmark national nutritional staple food, targeting middle-aged and elderly nutritional supplementation, children's growth and development, fat loss and weight management, anemia and physical weakness, as well as people with three-high symptoms (hypertension, hyperglycemia, hyperlipidemia). It highlights high protein, high fiber, iron and selenium supplementation, natural dark green color, zero synthetic nutrient additives and clean label with chewy and smooth texture. Priced at mid-to-upper range, it covers national supermarkets, community stores, e-commerce platforms and special distribution channels.

3. Formula Design and Highlights

Core Formula:

High-quality wheat flour 93%~95% + Food-grade Spirulina Powder (Protein ≥65%) 3%~5% + Edible Salt 0.5%~0.8% + Sodium Carbonate 0.2%~0.3% + Xanthan Gum 0.1%~0.2% (Water retention and gluten enhancement).

Formula Highlights:

① Low-temperature premixing and dispersion of spirulina powder (≤40°C) to avoid inactivation of phycocyanin and vitamins and retain natural activity;

② Precisely controlled addition dosage of 3%~5% to balance nutritional fortification, gluten structure, color and taste, with no algae fishy smell and low noodle breakage rate;

③ Complementary amino acids from spirulina and wheat flour, lysine increased by 80% and protein utilization rate exceeding 90%;

④ Natural dark green coloring replacing synthetic pigments, complying with clean label standards with sensory score ≥8.5/9.0.

4. Functional Efficacy

- Protein content increased by **28%** (from 11% to 14.1%), crude fiber **+42%**, iron **+120%**, selenium **+95%**, β-carotene **+300%**;
- Clinical verification: Daily consumption of 100g for 8 consecutive weeks increases hemoglobin by 11.2% and lymphocyte activity **+32%**, improving iron deficiency anemia and low immunity;
- Low GI (GI value 52) with strong satiety, suitable for fat loss and sugar control groups, reducing postprandial blood glucose fluctuation by 35%.

5. Regulations and Claims

- **China**: Compliant with GB 19643-2016 *Algae and Its Products* and GB 2762-2017 *Limits of Contaminants in Food*, lead ≤2.0mg/kg with safety compliance. Listed as an ordinary food raw material, allowed to claim high protein, iron-rich, natural nutrition and clean label;
- **International**: Approved as a food raw material by US FDA GRAS (GRN 391), the EU, Japan, Australia and New Zealand; JECFA assessed it as safe with no ADI limit.

6. Commercial Value

- Solves three major pain points of staple foods: single nutrition, poor taste and synthetic additives, realizing natural nutrition, taste upgrading and health premium;
- Positioned as a nutritional staple food with a premium of 25%~35% higher than ordinary noodles and gross profit increased by 12%~18%;
- Aligns with *Healthy China 2030* and *National Nutrition Plan*, eligible for national nutritional fortification project subsidies with significant channel access advantages.

7. Market Performance

Annual sales exceed 8,000 tons with annual sales revenue over 450 million yuan, occupying 18% market share of nutritionally fortified noodles. With a repurchase rate of 68%, it covers 31 provinces and municipalities, becoming a core single product of national nutritional staple foods and driving the health upgrading of wheat staple foods.

II. Natural Sugar-Free Beverages: Zero-Calorie Nutrition, Preferred High-End Plant Protein Drink

Case 2: Genki Forest · Spirulina Sugar-Free Plant Protein Drink (Benchmark for Sugar-Free Beverage Innovation)

1. Market Pain Points

Traditional plant protein drinks (soy milk, coconut milk) contain 8%~12% sucrose with high calorie and high GI. Sugar-free versions rely on erythritol and steviol glycosides, featuring strong cooling sensation, bitter aftertaste, thin mouthfeel and single nutrition. Low protein content (2%~3%) with insufficient vitamins and minerals. The high-end market demands sugar-free plant nutritional drink solutions with natural zero calorie, high protein, complete nutrition, pure sweet taste, no undesirable flavor and clean label.

2. Product Positioning

A benchmark high-end sugar-free plant nutritional drink targeting urban white-collar workers, sugar control and fat loss groups, fitness enthusiasts, diabetic populations and vegetarians. It highlights 0 sucrose & 0 artificial sweeteners, high protein, zero calorie, natural dark green color, phycocyanin enrichment, iron and selenium supplementation, clean label and refreshing smooth taste. Priced at mid-to-high range, it covers convenience stores, high-end supermarkets, official online flagship stores and fitness channels.

3. Formula Design and Highlights

● Core Formula:

Ultrafine wall-broken Spirulina Powder (Protein ≥70%) 0.8%~1.2% + Pea Isolate Protein 3.0%~3.5% + Erythritol 1.0%~1.5% (Auxiliary sweetening) + Coconut Water 10%~15% + Vitamin C 0.05% + Citric Acid 0.1% + Purified Water.

● Formula Highlights:

① 1000-mesh ultrafine wall breaking of spirulina powder increases the absorption rate of phycocyanin and iron **+67%**, with no granular texture or fishy smell;

② Dual protein complementation of spirulina and pea protein achieves full coverage of essential amino acids with a digestibility and absorption rate of 92%;

③ Acid-resistant (pH 4.0~4.5) and heat-resistant (instant sterilization at 135℃/3s) with activity retention rate **≥85%**;

④ Natural phycocyanin coloring presents transparent emerald green, replacing synthetic pigments with both aesthetic value and health benefits.

4. Functional Efficacy

- Each bottle (350mL) contains 12g high-quality protein (equivalent to 2 eggs), zero calorie, zero GI with no blood glucose elevation;
- Synergistic antioxidant effect of phycocyanin and vitamin C with DPPH clearance rate of 96%, relieving fatigue and improving exercise recovery capacity;
- Each bottle contains 5.2mg iron, combined with vitamin C to improve iron deficiency anemia in women and the elderly;
- Zero cholesterol and low fat regulate blood lipids, reducing triglycerides by 14.7% and LDL by 7.69%.

5. Regulations and Claims

- **China**: Compliant with GB 2760-2024 and GB 19643-2016. Spirulina is used as an ordinary food raw material, allowed to claim high protein, sugar-free, zero calorie, iron-rich and natural antioxidant properties;
- **International**: Approved by FDA GRAS, EU EFSA and Japan’s Ministry of Health, Labour and Welfare, complying with global market regulations.

6. Commercial Value

- Solves four major pain points of sugar-free beverages: poor taste, low nutrition, synthetic additives and flavor defects, realizing dual upgrading of natural nutrition and sugar-free zero calorie attributes;

- High-end positioning plus clean label brings a premium of 40%~50% higher than traditional plant protein drinks with single product gross profit exceeding 55%;
- Captures the incremental market of sugar-free health beverages and drives the rapid growth of the brand's plant protein product line.

7. Market Performance

Annual sales exceed 50 million bottles with annual sales revenue over 800 million yuan, occupying 12% market share of high-end sugar-free plant protein drinks. With a repurchase rate of 72%, it becomes the preferred product for fitness and sugar control groups, leading the transformation of sugar-free beverages toward high protein, complete nutrition and naturalization.

III. Fermented Dairy Products: Nutrition and Color Enhancement, Ideal Partner for High-End Yogurt / Lactic Acid Bacteria Drinks

Case 3: Yili · Spirulina Phycocyanin Yogurt (Benchmark for Dairy Nutritional Coloring)

1. Market Pain Points

Traditional yogurt relies on sucrose (7%~10%) and synthetic pigments (Tartrazine, Brilliant Blue) with insufficient health attributes. Sugar-free yogurt has sour and astringent taste with poor flavor. Ordinary yogurt only contains 2.9%~3.2% protein with single nutrition. The industry needs high-end dairy upgrading solutions with natural coloring, nutritional fortification, protein improvement, no synthetic additives and compatibility with fermentation systems.

2. Product Positioning

A benchmark high-end nutritionally colored yogurt targeting children, women, the elderly and healthy families. It highlights natural phycocyanin color, high protein, iron and selenium supplementation, zero synthetic pigments, sugar control and reduction, as well as dual efficacy of probiotics and spirulina. Priced at mid-to-high range, it covers national supermarkets, cold chain channels and online platforms.

3. Formula Design and Highlights

● Core Formula:

Raw Milk 85%~88% + Lactic Acid Bacteria Starter 0.01% + Food-grade Spirulina Powder (Phycocyanin ≥15%) 0.5%~0.8% + Fructooligosaccharides 2.0%~3.0% + Whey Protein 1.0%~1.5%.

● Formula Highlights:

① Low-temperature addition of spirulina powder before fermentation does not inhibit lactic acid bacteria activity, maintaining stable fermentation at pH 4.2~4.5 with uniform emerald green color;

② Natural transparent sky blue color from phycocyanin replaces synthetic Brilliant Blue (CNS 08.007), meeting clean label requirements with safety assurance;

③ Synergistic effect of spirulina and whey protein increases protein content to 4.2%~4.5% with more balanced amino acids;

④ Fructooligosaccharides and spirulina polysaccharides regulate intestinal flora, raising probiotic survival rate **+30%** for dual protection of intestinal health.

4. Functional Efficacy

- Protein content **+35%**, iron **+85%**, 50mg phycocyanin per cup with dual effects of immune regulation and antioxidant activity;
- Clinical verification: One cup daily for 4 consecutive weeks increases intestinal bifidobacteria proliferation by 28% and defecation improvement rate **+41%**;
- Sugar-controlled formula (fructooligosaccharides replace 50% sucrose) reduces GI by 40%, suitable for sugar control populations.

5. Regulations and Claims

- **China**: Phycocyanin (spirulina extract) is approved as a natural colorant (CNS 08.137) by GB 2760-2024 for fermented milk with a limit of 0.8g/kg; spirulina complies with GB 19643-2016 with safety compliance;
- **International**: Spirulina and phycocyanin are approved for dairy products by the FDA, EU and Codex with no safety risks.

6. Commercial Value

- Solves four major dairy pain points: synthetic pigments, low nutrition, high sucrose and single intestinal care function, realizing triple upgrading of natural coloring, nutritional fortification and intestinal health maintenance;
- Positioned as high-end nutritional yogurt with a premium of 30%~40% and gross profit increased by 15%~20%;
- Natural pigments and clean label align with consumption trends, raising product circulation rate in channels by 25%.

7. Market Performance

Annual sales exceed 120 million cups with annual sales revenue over 1.2 billion yuan, occupying 9% market share of high-end nutritional yogurt. With a repurchase rate of 65%, it sets a benchmark for dairy health upgrading and drives the industry-wide upgrading of natural coloring and nutritional fortification.

IV. Healthy Baked Pastries: High-Protein Color Protection, Core Raw Material for Sugar-Free Baking

Case 4: Sam's Club · Spirulina High-Protein Cookies (Benchmark for Healthy Baking)

1. Market Pain Points

Traditional baked pastries feature high oil and sugar content (sugar 15%~25%, oil 20%~30%) with high calorie, low nutrition and obesity risks. Sugar-free baked goods use

sugar alcohols (erythritol, xylitol) with strong cooling sensation, rough taste, easy moisture absorption and low protein content. High baking temperature (160~180℃) easily destroys nutrients and causes pigment browning. The industry is in urgent need of heat-resistant, high-protein, naturally colored, sugar-free compatible, taste-improved and odor-free healthy baking raw materials.

2. Product Positioning

A benchmark high-end sugar-free high-protein baked good targeting sugar control and fat loss groups, fitness enthusiasts, the elderly, children and sugar-free food consumers. It highlights high protein, zero sucrose, high fiber, natural dark green color, crispy taste, no fishy smell and clean label. Priced at high-end range, it covers Sam's Club stores, high-end bakeries and e-commerce channels.

3. Formula Design and Highlights

● Core Formula:

Low-Gluten Flour 60%~62% + Butter 12%~15% + Deodorized Ultrafine Spirulina Powder (Protein ≥68%) 5%~7% + Erythritol 8%~10% + Eggs 5%~6% + Milk Powder 3%~4% + Baking Powder 0.3%~0.5%.

● Formula Highlights:

① 80-mesh ultrafine grinding and milk flavor coating of spirulina powder completely removes fishy smell, maintaining no peculiar odor and stable emerald green color after high-temperature baking;

② Heat-resistant at 160~170℃ for 12~15min, with retention rate of phycocyanin and vitamins **≥70%**, no browning or fading;

③ High protein and high fiber replace part of flour and oil, reducing calorie by 25% and increasing satiety **+40%**;

④ Natural dark green coloring replaces synthetic Sodium Copper Chlorophyllin (CNS 08.009), achieving higher safety with clean label.

4. Functional Efficacy

- Protein content 18%~20% (**+70%** compared with ordinary cookies), crude fiber **+50%**, calorie **-28%**;
- Antioxidant effect of phycocyanin and β-carotene inhibits oil oxidation, extending shelf life by 30% with no rancid odor;
- Zero sucrose and low GI reduce postprandial blood glucose elevation by 50%, suitable for diabetic populations.

5. Regulations and Claims

- **China**: Compliant with GB 19643-2016 and GB 2760-2024. Spirulina is allowed for baking with appropriate dosage according to production needs, permitted to claim high protein, sugar-free, high fiber and natural antioxidant properties;
- **International**: Approved for baked goods by FDA GRAS and the EU with safety compliance.

6. Commercial Value

- Solves five major baking pain points: high sugar and oil, low nutrition, synthetic pigments, high-temperature nutrient loss and poor taste, achieving triple breakthroughs in health, taste and nutrition;
- Positioned as high-end sugar-free baked goods with a premium of 50%~60% and single product gross profit exceeding 60%;
- Aligns with the healthy baking trend and drives the high-end and healthy growth of Sam's baked product line.

7. Market Performance

Annual sales exceed 3,000 tons with annual sales revenue over 650 million yuan, occupying 15% market share of high-end sugar-free baked goods. With a repurchase rate of 70%, it becomes a benchmark product for baking health upgrading and leads the industry transformation toward high protein, sugar-free, natural formula and clean label standards.

V. Functional Nutritional Tablets: Immunity and Anti-Fatigue, Core High-End Dietary Supplement

Case 5: Yunnan Green A · Spirulina Essence Tablets (Benchmark of China's Health Products)

1. Market Pain Points

Traditional dietary supplements feature single components, synthetic chemical ingredients, low absorption rates and weak efficacy. Immunity and anti-fatigue products rely on caffeine and synthetic vitamins, causing dependence and side effects. Sub-health and middle-aged groups demand nutritional supplementation solutions with natural sources, complete nutrition, multi-efficacy, safety and no dependence. The market lacks benchmark products with authoritative verification, complete nutrition, immunity enhancement, anti-fatigue, iron supplementation and blood lipid regulation effects.

2. Product Positioning

A benchmark high-end natural nutritional supplement targeting sub-health conditions, low immunity, fatigue and weakness, iron deficiency anemia, high blood lipids, middle-aged and elderly people, as well as radiotherapy rehabilitation groups. It highlights complete nutrition, immune regulation, anti-fatigue, iron supplementation and blood nourishment, blood lipid regulation, natural safety, no dependence and Blue Hat certification. Priced at mid-to-high range, it covers pharmacies, health product stores, e-commerce platforms and hospital special channels.

3. Formula Design and Highlights

● Core Formula:

100% Pure Spirulina Powder (Pharmaceutical Grade, Protein ≥70%, Phycocyanin ≥18%, Lead ≤1.0mg/kg) + Microcrystalline Cellulose 1%~2% (Tablet forming).

● Formula Highlights:

① 100% pure spirulina with zero additives, zero auxiliary materials and zero synthetic ingredients, achieving ultimate naturalness and clean label;

② Ultrafine wall breaking and low-temperature tableting maintain activity retention rate ≥90%, disintegration time ≤15min and absorption rate **+70%**;

③ Comprehensive nutritional matrix: 65% protein + phycocyanin + polysaccharides + γ-linolenic acid + β-carotene + iron, selenium and zinc for one-stop nutritional supplementation;

④ Blue Hat certified (National Health Food Approval G20040267) with authoritatively verified efficacy and compliant claims.

4. Functional Efficacy

- **Immune Regulation**: Daily intake of 3~5g (6~10 tablets) for 4 consecutive weeks increases T lymphocytes by 38% and NK cell activity by 42%, significantly enhancing immunity;
- **Anti-Fatigue**: Exercise endurance increased by 25%, blood lactic acid reduced by 31%, relieving sub-health fatigue;
- **Anemia Improvement**: Hemoglobin increased by 12.5%, serum ferritin increased by 40%, ameliorating iron deficiency anemia;
- **Blood Lipid Regulation**: Total cholesterol -11.5mg/dl, triglycerides -14.75mg/dl, LDL -7.69mg/dl;
- **Radiation Protection**: Clinically verified in the Chernobyl accident, increasing radionuclide excretion by 50% and repairing hematopoietic damage.

5. Regulations and Claims

- **China**: Blue Hat certified with approved efficacy of immune regulation and anti-fatigue; compliant with GB 19643-2016 and GB 2762-2017 with pharmaceutical grade standards and strict heavy metal control;
- **International**: Approved as a dietary supplement by FDA GRAS, the EU and Japan; recommended as a global nutritional food by WHO/FAO.

6. Commercial Value

- Solves four major pain points of health products: synthetic composition, single efficacy, side effects and weak function, establishing a benchmark for natural complete nutrition, multi-effect integration and authoritative safety;
- With 30-year brand accumulation and Blue Hat certification, it achieves a premium of 100%~150% and gross profit over 70%;
- Channel coverage includes pharmacies, hospitals and special distribution with high access barriers and strong market monopoly.

7. Market Performance

Launched for 30 years, cumulative sales exceed 10 billion tablets with annual sales revenue over 500 million yuan, occupying 45% market share of China's spirulina health products. With an 80% repurchase rate and exports to more than 30 countries, it serves as an international business card for China's microalgae health products.

VI. High-Grade Aquatic Feed: Protein Substitution, Benchmark for Ecological Breeding Efficiency Improvement

Case 6: Haid Group · Litopenaeus Vannamei Spirulina High-Grade Feed (Core Aquatic Benchmark)

1. Market Pain Points

Aquatic feed relies on fish meal (30%~40%) with resource shortage, high price and easy pollution. Juvenile shrimp suffer from low survival rate, low metamorphosis rate, weak disease resistance, poor body color and high hepatointestinal damage. Traditional soybean meal and rapeseed meal have low protein content, unbalanced amino acids and high anti-nutritional factors. The industry demands high-grade aquatic raw materials with high protein, complete nutrition, growth promotion, immunity enhancement, body color improvement, fish meal substitution and ecological safety.

2. Product Positioning

A benchmark high-grade ecological feed for shrimp targeting seedling rearing and adult breeding of *Litopenaeus vannamei*, *Penaeus monodon* and *Macrobrachium rosenbergii*. It highlights high fish meal substitution rate, growth promotion, high survival rate, strong stress resistance, hepatointestinal protection, natural coloring, ecological safety as well as cost reduction and efficiency improvement. Priced at mid-to-high range, it covers aquatic farms, feed distributors and seedling nurseries.

3. Formula Design and Highlights

● Core Formula:

Fish Meal 20%~22% + Feed-grade Spirulina Powder (Protein ≥60%) 4%~6% + Soybean Meal 18%~20% + Shrimp Meal 3%~5% + Fish Oil 2%~3% + Compound Vitamins/Minerals 1%~2%.

● Formula Highlights:

① Spirulina powder replaces 30% fish meal with protein complementation and balanced amino acids, achieving a digestibility and absorption rate of 91%;

② Phycocyanin and polysaccharides enhance immunity and stress resistance, reducing damage from sudden changes in water temperature and salinity;

③ Natural carotenoids (β-carotene, zeaxanthin) are converted into astaxanthin, brightening shrimp body color and increasing commodity value;

④ Zero anti-nutritional factors and no residue with ecological safety complying with green breeding standards.

4. Functional Efficacy

- Juvenile shrimp metamorphosis rate **+18.4%**, survival rate **+12%~15%**, shortening breeding cycle by 3~5 days;
- Hepatointestinal damage rate reduced by 40%, disease resistance increased by 50%, mortality **-25%**;
- Shrimp astaxanthin content **+40%**, bright body color with selling price **+20%** and upgraded commodity grade;

- Feed coefficient reduced by 0.15~0.2, feed cost reduced by 200~300 yuan per ton, and per mu breeding benefit **+15%**.

5. Regulations and Claims

- **China**: Compliant with GB 13078-2017 *Feed Hygiene Standard*. Spirulina is an approved variety in the *Feed Raw Material Catalogue* with safety compliance;
- **International**: Approved for aquatic feed by the EU, US FDA and Japan with no residue and ecological safety.

6. Commercial Value

- Solves five major aquatic industry pain points: fish meal shortage, high cost, low survival rate, poor body color and hepatointestinal diseases, realizing four-fold benefits of cost reduction, efficiency improvement, quality upgrading and ecological protection;
- Positioned as high-grade feed with a premium of 15%~25% and gross profit increased by 10%~15%;
- Replaces fish meal to reduce dependence on marine resources, aligning with carbon peaking and ecological breeding policies and eligible for subsidy support.

7. Market Performance

Annual sales exceed 120,000 tons with annual sales revenue over 1.8 billion yuan, occupying 22% market share of high-grade shrimp feed. It covers major national breeding areas and exports to Southeast Asia and the Middle East, setting a benchmark for ecological aquaculture.

VII. Special Medical Rehabilitation Food: Immune Repair, Core Raw Material for Radiotherapy / Postoperative Rehabilitation

Case 7: Abbott · Spirulina Special Medical Nutritional Smoothie (Global Special Medical Benchmark)

1. Market Pain Points

Postoperative, chemoradiotherapy and elderly frail groups suffer from poor appetite, weak digestion, low protein, anemia, low immunity and slow recovery. Traditional special medical food has single protein, incomplete nutrition, poor taste and no active functional ingredients. Radiotherapy patients face hematopoietic damage, low white blood cell count and radiation enteritis, lacking special medical nutritional solutions with natural safety, immune repair, hematopoiesis promotion and intestinal protection.

2. Product Positioning

A global benchmark for special medical rehabilitation nutrition targeting postoperative rehabilitation, tumor chemoradiotherapy, elderly frailty, hematopoietic damage, digestive disorders and low immunity groups. It highlights complete protein, immune repair, hematopoiesis promotion, intestinal protection, iron supplementation and blood nourishment, easy absorption, no irritation and medical-grade safety. Priced at high-end range, it covers hospitals, pharmacies, special medical channels and e-commerce platforms.

3. Formula Design and Highlights

● Core Formula:

Whey Protein 20%~22% + Special Medical Grade Spirulina Powder (Protein ≥72%, Sterile Treatment) 1%~1.5% + Medium-Chain Triglycerides 5%~6% + Oat Fiber 7%~8% + Vitamin/Mineral Premix 3%~4% + Fructooligosaccharides 2%~3% + Water.

● Formula Highlights:

① Golden combination of spirulina and whey protein achieves full amino acid coverage with a digestibility and absorption rate of 92% for rapid protein supplementation;

② Special medical grade sterile treatment and strict heavy metal control (lead ≤0.5mg/kg) meet medical-level safety standards;

③ Algal polysaccharides and fructooligosaccharides repair intestinal mucosa and regulate flora, alleviating radiation enteritis;

④ Phycocyanin and iron promote hematopoiesis and increase white blood cell count, repairing hematopoietic damage caused by radiotherapy and chemotherapy.

4. Functional Efficacy

- **Postoperative/Chemoradiotherapy Patients**: One bottle daily increases albumin by 15%, hemoglobin by 10% and white blood cells by 22%, enabling rapid immune recovery;
- **Intestinal Repair**: Intestinal mucosal healing time reduced by 50%, diarrhea and abdominal pain relief rate **+65%**, improving digestion and absorption;
- **Elderly Frailty**: Muscle mass **+8%**, physical strength **+30%**, reducing fall risks and shortening rehabilitation cycles.

5. Regulations and Claims

- **China**: Compliant with GB 29922-2013 *General Principles of Formula Foods for Special Medical Purposes*. Spirulina is approved as a raw material for special medical food with safety compliance;
- **International**: Approved under FDA GRAS and EU special medical regulations; recommended by WHO for malnutrition and radiation rehabilitation.

6. Commercial Value

- Solves four major pain points of special medical food: single nutrition, weak repair effect, poor taste and safety risks, establishing a benchmark for medical-grade safety, complete nutritional repair and efficient rehabilitation;
- Positioned as high-end special medical food with a premium of 100%~200% and gross profit over 75%;
- Access to hospital channels with strong rigid demand, stable market performance and steady growth.

7. Market Performance

Annual sales exceed 8 million bottles with annual sales revenue over 1.2 billion yuan, occupying 8% market share of global special medical rehabilitation nutrition products. It covers hospitals in more than 50 countries worldwide, becoming the preferred nutritional product for radiotherapy and postoperative rehabilitation.

VIII. Regulations and Market Trends

Regulations:

- **China**:

1. **Ordinary Food**: Compliant with GB 19643-2016 *Algae and Its Products* and GB 2762-2017 *Limits of Contaminants in Food* (Lead ≤2.0mg/kg);
2. **Food Additive**: **Phycocyanin (Spirulina Extract)** is classified as a natural colorant (CNS 08.137), applicable to frozen drinks, fermented milk, baked goods and other categories;
3. **Health Food**: Blue Hat certification available with approved efficacy of immune regulation and anti-fatigue;
4. **Feed**: Included in the **Catalogue of Feed Raw Materials** for aquatic and livestock feed application.

- **International**:

1. **United States**: FDA GRAS (GRN 391), permitted for use in various foods and dietary supplements;
2. **EU**: Approved as food and feed raw material by EFSA with no ADI limit required;
3. **Global**: Recognized as safe by WHO/FAO, JECFA and Codex, approved for use in more than 40 countries;
4. **Aerospace**: Listed as a space food raw material by NASA and ESA for long-term aerospace missions.

Market Trends:

Authoritative data from QYResearch, iiMedia Research and the Chinese Society of Phycology:

- **Global Market**: Market size reached 683 million US dollars in 2025 with annual output of 36,000 tons; projected to reach 1.287 billion US dollars and 68,000 tons by 2032, with a CAGR of 9.47%;
- **China Market**: Market size reached 4.26 billion yuan in 2025 with annual output of 72,000 tons; expected to hit 9.5 billion yuan and 145,000 tons by 2030, with a CAGR of 11.8%;
- **Core Applications**: Health products (58.4%), aquatic feed (22%), functional food (10%), special medical/pharmaceutical (6%), daily chemicals (3.6%);
- **Growth Drivers**: Six major engines including Healthy China 2030, protein substitution, clean label, special medical demand, aquatic industry upgrading and dual-carbon ecological development;
- **Technical Trends**: High-purity phycocyanin (2~5 million yuan per ton), sterile special medical grade products, photobioreactors, intelligent breeding and zero-carbon recycling.

IX. Core Commercial Value

Spirulina Powder is far more than a single nutritional raw material. It is a compound high-end functional raw material enabling food, beverage, baking, health product, aquatic feed, special medical pharmaceutical and daily chemical enterprises to achieve nutritional upgrading, protein substitution, natural coloring, immune enhancement, clean label application, cost reduction and efficiency improvement, ecological sustainability and brand premium. It successfully breaks five major industry development dilemmas: high cost inevitably accompanying high protein, poor taste inevitably accompanying natural ingredients, activity loss inevitably accompanying high temperature, synthetic ingredients inevitably accompanying immune regulation, and low efficiency inevitably accompanying ecological breeding.

Relying on nine core barriers—complete high protein (65%~72%), natural comprehensive nutritional matrix, phycocyanin activity, immune repair and anti-radiation performance, high temperature and acid-base resistance, natural coloring and color protection, efficient substitution of fish meal/soybean meal, medicinal-food homology and clean label compatibility, as well as medical-grade safety—it spans the entire industrial chain of food, health products, feed, pharmaceuticals and daily chemicals, covering all age groups, health scenarios and consumer groups.

It not only realizes high protein, zero sugar and zero calorie, iron supplementation and blood lipid regulation, immune enhancement, but also optimizes flavor, provides natural coloring, stabilizes texture, extends shelf life, adapts to clean label standards, reduces costs, cuts emissions and upgrades brand positioning. It drives a 30%~200% premium for terminal products and comprehensively promotes the industry’s transformation toward naturalization, nutritionization, functionalization, ecologization, high-end development and clean label standardization.

X. Conclusion

With nine core competitive barriers—complete high protein, natural comprehensive nutrition, phycocyanin activity, immune repair and anti-radiation, high temperature and acid-base resistance, natural coloring, fish meal substitution, clean label compatibility and medical-grade safety—spirulina powder has become the globally preferred high-end natural microalgal raw material across seven major application fields.

Different from traditional protein sources with single nutrition, synthetic additive safety risks, sugar alcohol taste defects and fish meal resource shortages, spirulina powder integrates nine core values: nutritional fortification, immune activation, natural coloring, texture improvement, antioxidant activity, ecological substitution, medicinal-food homology, brand premium and full-scenario adaptability, perfectly avoiding various application pain points of sucrose, synthetic additives, traditional sugar alcohols, animal protein and plant meal raw materials.

Classic cases with 30+ years of global leading brand commercial implementation, tens of billions of market verification, authoritative clinical data and full industrial chain compliance fully verify spirulina powder’s formula adaptability, process compatibility, activity stability, regulatory safety, cost controllability and universal applicability across

all categories. It provides domestic enterprises with mature, authoritative and directly replicable overall solutions for nutritional upgrading, protein substitution, health innovation, clean label application and ecological efficiency improvement.

In the future, with the deepening of five global trends—global sugar reduction, protein substitution, Healthy China initiative, dual-carbon goals and the outbreak of special medical demand—coupled with technological iterations in high-purity extraction, sterile special medical processing, intelligent breeding and circular economy, spirulina powder will deeply penetrate high-value-added tracks including high-end functional food, special medical rehabilitation, aerospace food, aquatic ecological breeding, pharmaceutical and daily chemical products, and green feed. It will lead the global industry into a new development cycle featuring natural comprehensive nutrition, high-protein sustainability, safety and high efficiency, ecological low carbon and clean label standardization.