Safety Assessment, Product Applications and Recommended Dosage of Spirulina Powder

Overview

Spirulina Powder is a natural microalgae powder produced from **Arthrospira platensis** and **Arthrospira maxima** through artificial cultivation, harvesting, washing, filtration, low-temperature drying, crushing, sterilization and other processes. It is a high-protein, high-nutrient-density and low-calorie functional food raw material. Rich in active ingredients such as phycocyanin, β-carotene, γ-linolenic acid, algal polysaccharides, iron and B vitamins, it possesses physiological functions including immune regulation, antioxidant, anti-fatigue, auxiliary blood lipid regulation, hematopoiesis promotion and nutritional fortification. Included in authoritative standards such as **GB 2760**, **GB/T 16919-2022**, **FDA GRAS**, EU Food Regulations and **JECFA**, it features high safety and wide applicability, and can be used in ordinary food, health food, special dietary food, feed, cosmetics and other fields.

I. Safety Assessment of Spirulina Powder

(I) Conclusions of Toxicological Tests

1. Acute Toxicity

In accordance with **GB 15193 Toxicology Evaluation Procedures and Methods for Food Safety**, oral acute toxicity tests in mice and rats show that the LD_{50} of Spirulina Powder is >5000mg/kg·bw, classified as a practically non-toxic substance. No death or toxic symptoms were observed in test animals, with no abnormalities in behavior, food intake, body weight or visceral organs. Conventional intake carries no risk of acute poisoning.

2. Subchronic and Chronic Toxicity

90-day and 18-month long-term feeding trials in rats demonstrate that under high-dose intake (1.0–5.0g/kg·bw), there are no significant abnormalities in animal growth and development, blood routine, blood biochemistry or organ coefficients, with no organic visceral damage or cumulative toxicity. **NOAEL (No Observed Adverse Effect Level)** is far higher than the recommended human intake. Long-term consumption has no adverse effects on the liver, kidneys, intestines and other organs.

3. Genotoxicity and Carcinogenicity

Ames test, mouse bone marrow micronucleus test, chromosome aberration test and sperm abnormality test all show negative results, with no mutagenicity, chromosome

damage or teratogenic risks. Long-term animal carcinogenicity tests show no increased tumor incidence and no carcinogenicity, complying with safety requirements for food-grade raw materials.

4. Reproductive and Developmental Toxicity

Animal experiments confirm that conventional doses of Spirulina Powder have no adverse effects on the reproductive system, embryonic development and offspring growth, with no embryonic malformation, stillbirth or growth retardation. It is safe for pregnant women, lactating women and infants (≥3 years old) within the recommended dosage. High-dose intake may only cause mild intestinal adaptive reactions such as flatulence and loose stools, without irreversible damage.

(II) Hazardous Substances and Limit Control (In accordance with GB/T 16919-2022, GB 2762)

1. Physical and Chemical Purity Control

- Protein: Grade I ≥60%, Qualified Grade ≥55% (core nutritional indicator)
- Moisture: ≤8.0%
- Crude Ash: ≤8.0%
- Phycocyanin: ≥10% (dry basis, characteristic active ingredient)

2. Limits of Heavy Metals and Harmful Elements

- Lead (Pb): ≤0.5mg/kg
- Cadmium (Cd): ≤0.1mg/kg
- Total Arsenic (As): ≤0.3mg/kg (Inorganic Arsenic ≤0.2mg/kg)
- Total Mercury (Hg): ≤0.05mg/kg
- Microcystin (MC-LR): ≤1.0μg/kg (prevent cyanotoxin contamination)

3. Microbial Indicators

- Total Aerobic Bacteria: ≤1.0×10^4CFU/g
- Coliforms: ≤0.3MPN/g
- Molds and Yeasts: ≤50CFU/g
- Salmonella, Staphylococcus aureus: 0/25g (not detectable)

4. Allergenicity and Irritation

Spirulina Powder is non-allergenic and non-irritating to gastrointestinal mucosa via oral administration, causing no allergic reactions. A very small number of people may experience intestinal adaptive reactions such as abdominal distension, increased exhaust and loose stools with initial high-dose intake, which can be quickly relieved by continuous consumption or dosage reduction.

5. Risks for Special Populations

- Patients with impaired liver and kidney function: High protein and minerals may increase metabolic burden, use with caution.
- Patients with autoimmune diseases (lupus, rheumatoid arthritis): Algal polysaccharides may activate immunity, use with caution.
- Gout / Hyperuricemia: Relatively high purine content, daily intake ≤3g.
- Patients with thyroid diseases: Contains iodine (about 50μg/5g), thyroid function needs regular monitoring.
- People taking anticoagulant drugs (Warfarin, etc.): Take at an interval of ≥2 hours.
- Infants (<3 years old): Immature intestinal development, use under medical advice.

(III) Safety Conclusions from Authoritative Institutions

- **China:**

  Approved as ordinary food raw material and health food raw material (GB/T 16919-2022, GB 2760), allowed for appropriate use according to production requirements.
- **United States:**

  Recognized as **FDA GRAS** substance with no strict upper limit on daily intake.
- **European Union:**

  Approved for food and feed raw materials with unrestricted ADI, supporting health claims for immune regulation and antioxidant effects.
- **FAO/WHO:**

  Praised as "the most ideal nutritional source of the 21st century" with sufficient toxicological data and high safety.
- **Japan:**

  Included in the **Official Book of Food Additives**, widely applied in health food and feed.

II. Product Applications of Spirulina Powder

(I) Health Food Sector

● Core Value

High content of phycocyanin, algal polysaccharides, β-carotene, iron and γ-linolenic acid exert functions including immune regulation, antioxidant, anti-fatigue, auxiliary blood lipid regulation, hematopoiesis promotion and anemia improvement. Suitable for sub-health populations, immunocompromised groups, anemic people, hyperlipidemia patients and easy-fatigue crowds.

● Applicable Products

- Spirulina tablets / capsules / powder (pure powder or compound formula)
- Multinutrient supplements, multi-vitamin and mineral tablets
- Anti-fatigue, immune-regulating and blood lipid-regulating health foods
- Sports nutrition and post-operative rehabilitation nutritional supplements

(II) Ordinary Food and Beverage Sector

● Core Value

Natural green/blue-green pigment (phycocyanin), high-protein nutritional fortification, texture improvement and flavor enhancement. It can replace synthetic pigments and conform to the consumption trend of natural, healthy and additive-free products.

● Applicable Products

- Beverages: Fruit and vegetable juice, protein drinks, carbonated drinks, solid beverages, meal replacement shakes
- Baked Goods: Bread, cakes, biscuits, noodles, oatmeal, nutrition bars
- Dairy Products: Yogurt, formulated milk, ice cream, cheese
- Candy and Snacks: Jelly, pudding, gummy candy, chocolate, sugar-free candy
- Meat / Meat Analog Products: Water retention, protein enrichment, color adjustment and tenderness improvement

(III) Infant Formula and Special Dietary Food

● Core Value

High-quality source of plant protein, iron, vitamins and minerals with comprehensive nutrition and high digestibility **>95%**. Applied in infant complementary foods (≥3 years old), nutrition sachets and food for special medical purposes **to promote growth and development, improve nutritional anemia and regulate intestinal health, complying with national standard requirements for nutritional fortification.

(IV) Feed Industry Sector

● Core Value

High-protein source (60–70%), natural colorant (phycocyanin, carotenoids) and immune enhancer. It can partially replace fish meal / soybean meal, promoting growth, enhancing disease resistance and improving meat / body color.

● Applicable Products

- Aquaculture: Shrimp, crab, fish, shellfish (color enhancement, growth promotion, immunity improvement)
- Livestock and Poultry: Laying hens (deepen yolk color), broilers, pigs
- Pets: Dogs, cats (hair beautification, immunity enhancement, nutritional supplementation)
- Ornamental Fish / Rare Birds: Natural coloring and vitality enhancement

(V) Cosmetics and Daily Chemicals Sector

● Core Value

Phycocyanin, chlorophyll, SOD and polysaccharides have antioxidant, anti-inflammatory, moisturizing, brightening and skin-repairing effects. Used as natural blue-green pigment and nutritional additives, mild and safe for sensitive skin.

● Applicable Products

- Skin Care: Facial masks, face creams, essences, lotions, cleansing products
- Makeup: Eyeshadow, blush, lipstick, pressed powder (natural pigment)
- Hair Care: Shampoo, hair mask, conditioner (nourishment, repair and color fixation)

III. Recommended Dosage by Sector

Based on **Food / Health Grade Spirulina Powder (GB/T 16919-2022, Grade I)**.

(I) Health Food

- Tablets / Capsules: 200–500mg per piece/capsule, 1–5g daily (health maintenance dosage)
- Powder / Solid Beverage: 1–5g per sachet, 1–2 times daily
- Immune Regulation / Anti-Fatigue: 2–5g daily
- Blood Lipid Regulation / Anemia Improvement: 3–6g daily
- Daily Safe Upper Limit for Adults: ≤10g/day (short-term intake)

(II) Ordinary Food and Beverage

- Liquid Beverages: 0.1%–0.3% (coloration and nutritional fortification)
- Solid Beverages / Meal Replacement Powder: 1%–5%
- Flour Products (Noodles / Steamed Buns): 0.2%–0.5%
- Baked Goods (Bread / Biscuits): 0.3%–1.0%
- Candy / Jelly / Pudding: 0.1%–0.5%
- Dairy Products / Ice Cream: 0.2%–0.8%
- Meat / Meat Analog Products: 0.5%–2.0%

(III) Infant Formula and Complementary Foods (≥3 Years Old)

- Infant Complementary Foods / Nutrition Sachets: 0.1%–0.3% (in accordance with national standards)
- Food for Special Medical Purposes: 1.0%–3.0% (per product standards)

(IV) Feed Sector

- Aquaculture (Shrimp / Crab / Fish): 3%–8% in compound feed
- Laying Hens: 2%–5% (yolk coloring and laying rate improvement)
- Broilers / Ducks: 1%–3%
- Live Pigs (Piglets / Fattening Pigs): 1%–2%
- Pets (Dogs / Cats): 1%–3%

- Ornamental Fish: 5%–10%

(V) Cosmetics Sector

- Creams / Lotions / Essences: 0.5%–2.0%
- Facial Masks: 1.0%–3.0%
- Makeup (Eyeshadow / Blush): 1.0%–5.0%
- Shampoo / Conditioner: 0.5%–2.0%

IV. Application Precautions and Quality Control

(I) Raw Material Quality Standards (GB/T 16919-2022)

- Appearance: Dark green powder, no peculiar odor, no caking, no impurities
- Purity: Protein ≥55% (Grade I ≥60%), Phycocyanin ≥10%
- Sanitation: Heavy metals, microorganisms and microcystins comply with national standard limits
- Solubility: Good water dispersibility with no obvious precipitation

(II) Processing and Compatibility

- Temperature: Processing temperature **≤65℃** to avoid inactivation of phycocyanin and vitamins
- Compatibility: Combined with vitamin C, iron absorption rate increases by 67%; good compatibility with probiotics and minerals
- Contraindication: Take at an interval of **≥2 hours** with anticoagulant and thyroid medications

(III) Consumption Recommendations

- Initial Intake: Start with 0.5–1g/day for gradual adaptation to reduce gastrointestinal discomfort
- Administration: Divide into 2 servings with meals, water temperature **<40℃** to prevent active ingredient loss
- Reminder: It cannot replace drugs for the treatment of immune diseases, dyslipidemia, anemia and other illnesses

(IV) Storage Conditions

Store in a sealed, cool, dry and dark place at temperature **≤25℃**, moisture-proof and sun-proof. Unopened shelf life: 24 months **; use up within 3 months after opening.

V. Summary

Spirulina Powder is a natural microalgae raw material with sufficient toxicological data and extremely high safety. It is non-toxic, non-allergenic, non-carcinogenic and non-mutagenic. Special populations show good tolerance within recommended doses, with only mild initial intestinal adaptive reactions possibly occurring under high-dose intake. Featuring high nutritional density and abundant active ingredients, it has multiple values including nutritional fortification, natural coloring, functional regulation and texture improvement. Widely applicable in health food, ordinary food, infant complementary food, feed, cosmetics and other fields, it serves as a core high-quality raw material for the modern health industry, green food and functional feed sectors.

In practical application, it is necessary to strictly follow national standard limits, control dosage addition, select qualified raw materials and standardize production processes to ensure product safety, stability and effectiveness. Suitable for all age groups (≥3 years old), Spirulina Powder conforms to the industrial trend of naturality, health and sustainability, boasting broad application prospects in high-growth tracks such as nutritional fortification, immune health, natural pigments and green feed.