Application Areas & Addition Method Operation Guide of Garlic Extract

I. Preface

This Guide is formulated based on the physicochemical properties, stability rules and industry-specific application scenarios of garlic extract (with allicin, garlic oil, alliin, S-allylcysteine and other core active ingredients), standardizing the addition principles, processes, dosages, operation points and quality control in six major fields: food, feed, medicine, cosmetics, agriculture and industry, so as to provide standardized operational basis for large-scale production.

1.1 Basic Properties of Garlic Extract

- Forms: Oily liquid (garlic oil, CAS 8008-99-9), powder (alliin/stabilized extract), microcapsule/microemulsion dosage forms.
- Solubility: Oily form is freely soluble in ethanol and vegetable oils but poorly soluble in water; powder is partially soluble in hot water; microcapsules/microemulsions are water-dispersible.
- Stability: Sensitive to heat (rapid degradation above 40°C), alkali (pH>11) and light; most stable at pH 5–6; microencapsulation improves stability against high temperature, acid and alkali.
- Core activities: Antibacterial, antioxidant, anti-inflammatory, immune regulation, flavor enhancement.

1.2 General Addition Principles

1. **Dosage Form Matching**: Use garlic oil for oil-soluble systems, and microcapsules/microemulsions/water-soluble powders for water-soluble systems. Avoid direct addition of oily extracts to aqueous phases.
2. **Temperature Control**: Addition temperature ≤40°C. For high-temperature processes (frying, cooking), prefer stabilized microcapsules or add at the late low-temperature stage of the process.
3. **pH Adaptation**: Prioritize addition in systems at pH 5–6; stability must be verified by pre-experiments in strong acid/strong alkali systems.
4. **Compatibility Contraindications**: Avoid direct mixing with strong oxidants and alkaline substances. 易 oxidizes in contact with metal ions (Fe, Cu); stainless steel equipment shall be used.

5. **Flavor Masking**: At high addition levels, use β-cyclodextrin or sodium octenylsuccinate starch for embedding, or compound with spices (ginger, pepper) to mask pungency.
6. **Quality Traceability**: Use extracts conforming to GB 1886.272 and feed/pharmaceutical grade standards, and keep batch inspection reports (allicin/alliin content, microorganisms, heavy metals).

II. Food Industry Addition Operation Guide

2.1 Applicable Categories & Core Functions

- Meat products (sausages, hams, marinated products, prepared dishes): Antiseptic, antibacterial, antioxidant, garlic flavor enhancement, shelf life extension.
- Condiments (sauces, hot pot bases, soy sauce, savory flavors): Flavor enhancement, natural preservation, partial replacement of chemical preservatives.
- Convenience foods (instant noodles, puffed foods, fried foods): Antioxidation (retarding rancidity), aroma enhancement, flavor layering.
- Beverages, baked goods, pickled foods: Functional addition (antioxidation), flavor modification.

2.2 Dosage Form Selection & Addition Methods

(1) Garlic Oil (Oil-Soluble)

- Applications: Fat systems, fried foods, fat phase of meat products, savory flavors.
- Addition methods:
    1. Directly mix into fats (lard, vegetable oil), stir well before adding to the formula;
    2. Premix with emulsifiers (monoglycerides, sucrose esters, HLB 9) to form a water-in-oil emulsion, then add to aqueous systems;
    3. Process nodes: Curing/tumbling stage of meat products, mixing before frying, late stage of sauce boiling (≤50°C).
- Recommended dosage: Meat products 0.01%–0.03%; instant noodles 0.02%–0.03%; spicy foods 0.02%–0.05%; savory flavors 0.1%–0.3%.

(2) Water-Soluble Garlic Extract / Microcapsules (Alliin ≥1%, Allicin Microcapsules)

- Applications: Water-based sauces, beverages, bakery doughs, pickling solutions, frozen prepared dishes.

- Addition methods:
    1. Directly dissolve powder in warm water (30–40°C), stir to full dispersion before adding to the formula;
    2. Premix microcapsules with other powder raw materials (starch, maltodextrin), then add to aqueous phase;
    3. Process nodes: Sauce preparation, beverage batching, dough mixing, pickling solution preparation (≤40°C throughout).
- Recommended dosage: Sauces 0.1%–0.5%; beverages 0.01%–0.05%; baked goods 0.02%–0.1%; pickled foods 0.1%–0.5%.

(3) Stabilized Garlic Extract (S-Allylcysteine, Aged Extract)

- Applications: Functional foods, dietary supplements, high-temperature resistant systems (canned foods, thermally sterilized foods).
- Addition methods: Same as water-soluble powder; resistant to short-time sterilization at 100°C, more stable than allicin.
- Recommended dosage: Functional foods 0.05%–0.2%; dietary supplements added per functional requirement (alliin ≥5%).

2.3 Operation Points & Quality Control

1. Temperature control: Addition and mixing temperature ≤40°C; supplement after high-temperature processes. Use microcapsules for fried foods to avoid direct contact above 180°C.
2. Uniformity: Oily extracts must be fully emulsified; powders must be sieved (80–100 mesh) before premixing to prevent excessive local concentration.
3. Synergistic preservation: Compound with nisin and ε-polylysine to reduce addition by 30%–50% and improve antibacterial effect.
4. Flavor balance: At addition >0.3%, compound with ginger and onion extracts to reduce pungency.
5. Compliance: Strictly follow GB 2760; garlic oil as a food flavor may be used appropriately as needed for production; functional additions shall comply with health food regulations.

III. Feed Industry Addition Operation Guide

3.1 Applicable Categories & Core Functions

- Livestock and poultry feed (swine, chicken, duck): Antibiotic replacement, growth promotion, antibacterial and antidiarrheal, immunity enhancement, meat quality

improvement.

- Aquafeed (fish, shrimp): Antibacterial, anti-stress, intestinal health improvement, feed coefficient reduction.
- Ruminant feed: Regulation of rumen microorganisms, feed conversion rate improvement.

3.2 Dosage Form Selection & Addition Methods

(1) Feed-Grade Allicin Powder (Allicin Content 1%–10%)

- Applications: Complete feed, premix, concentrate feed.
- Addition methods:
    1. First mix with vitamin and mineral premixes (premix ratio 1:5 to 1:10), then add to basal feed;
    2. Adopt stepwise dilution (10× → 100× → 1000×) to ensure uniform distribution;
    3. Process nodes: Feed mixing stage (room temperature, ≤35°C); avoid high-temperature pelleting (pelleting temperature ≤70°C, post-spraying preferred).
- Recommended dosage: Piglets 0.01%–0.03%; finishing pigs 0.005%–0.02%; broilers/layers 0.008%–0.02%; aquaculture 0.01%–0.04%.

(2) Garlic Oil Microcapsules (Embedding Rate ≥85%)

- Applications: High-temperature pelleted feed, water-resistant aquafeed.
- Addition methods: Directly add to mixer, or spray after pelleting (spraying temperature ≤50°C) to improve high-temperature stability.
- Recommended dosage: Same as allicin powder; higher utilization rate of active ingredients in microcapsules allows 10%–20% dosage reduction.

3.3 Operation Points & Quality Control

1. Uniformity: Stepwise dilution is mandatory; direct addition of high-concentration allicin to bulk feed is prohibited to prevent local poisoning.
2. Temperature control: Pelleting temperature ≤70°C; use post-spraying if exceeded. Storage temperature ≤25°C, sealed and protected from light.
3. Compatibility safety: Use synergistically with probiotics and enzyme preparations; avoid direct mixing with strong alkaline additives (quicklime).
4. Effect verification: Regularly detect allicin residue in feed, livestock intestinal flora and growth performance to optimize dosage.
5. Compliance: Use feed-grade garlic extract conforming to the *Catalogue of Feed Additives*, and keep manufacturer qualifications and inspection reports.

IV. Pharmaceutical / Dietary Supplement Industry Addition Operation Guide

4.1 Applicable Categories & Core Functions

- Medicines: Antibacterial, anti-inflammatory, antiviral, blood lipid-lowering, adjuvant anti-tumor (allicin injection, capsules).
- Dietary supplements: Immunity enhancement, blood lipid regulation, antioxidation (allicin soft capsules, alliin tablets, aged garlic extract).

4.2 Dosage Form Selection & Addition Methods

(1) Allicin Oil (Pharmaceutical Grade, Purity ≥98%)

- Applications: Soft capsules, injections, topical preparations.
- Addition methods:
    1. Soft capsules: Mix with soybean oil or corn oil, add gelatin-glycerol shell material, and compress into soft capsules (process temperature ≤40°C);
    2. Injections: Cosolubilize with ethanol (30%–50% ethanol), adjust pH to 5–6, sterile filter and fill;
    3. Topical ointments: Mix with petrolatum and lanolin, emulsify at low temperature.
- Recommended dosage: 3–6 mg allicin per soft capsule; injections added per prescription (in accordance with pharmacopoeia).

(2) Alliin / Stabilized Extract Powder (Pharmaceutical Grade, Alliin ≥5%, S-Allylcysteine ≥1%)

- Applications: Tablets, granules, capsules, oral liquids.
- Addition methods:
    1. Tablets/capsules: Mix with microcrystalline cellulose, lactose, magnesium stearate, dry/wet granulation (granulation temperature ≤50°C);
    2. Oral liquids: Dissolve in warm water, add sweeteners and stabilizers (xanthan gum), adjust pH to 5–6, sterile filling.
- Recommended dosage: 50–100 mg alliin per tablet; oral liquids added per functional requirement (daily alliin intake 100–300 mg).

(3) Aged Garlic Extract (AGE, S-Allylcysteine ≥0.5%)

- Applications: High-end dietary supplements, long-term use preparations (optimal stability, no pungency).
- Addition methods: Same as water-soluble powder; resistant to conventional sterilization, high bioavailability.

- Recommended dosage: Daily S-allylcysteine intake 100–200 mg; dosage converted per product specification.

4.3 Operation Points & Quality Control

1. GMP compliance: Production environment cleanliness Grade D or above, dedicated equipment to avoid cross-contamination.
2. Stability: Allicin preparations stored protected from light, sealed and refrigerated (2–8°C); alliin/AGE preparations storable at room temperature.
3. Content control: Batch testing of allicin, alliin and S-allylcysteine content, deviation ≤±5%.
4. Safety: Pharmaceutical-grade extracts tested for heavy metals (Pb≤2mg/kg, As≤1mg/kg), microorganisms (sterility/limit test), solvent residues (ethanol≤0.5%).
5. Efficacy verification: Dietary supplements shall complete animal tests and human feeding trials to ensure efficacy.

V. Cosmetic Industry Addition Operation Guide

*(in compliance with the *Safety and Technical Specifications for Cosmetics*)

5.1 Applicable Categories & Core Functions

- Skin care products: Antibacterial, anti-inflammatory, antioxidant, anti-acne, soothing sensitivity, anti-aging (creams, essences, masks).
- Toiletries: Anti-dandruff, antibacterial, oil control (shampoos, body washes, hand sanitizers).
- Color cosmetics: Natural preservation, antioxidation (lipsticks, foundations).

5.2 Dosage Form Selection & Addition Methods

(1) Garlic Oil / Stabilized Garlic Extract (Cosmetic Grade, Non-Irritating)

- Applications: Creams, lotions, essential oils, shampoos.
- Addition methods:
    1. Oil-phase systems (creams, essential oils): Directly add to oil phase (jojoba oil, squalane), heat to 40°C and stir to dissolve;
    2. Aqueous-phase systems (shampoos, masks): Presolubilize with ethanol (10%–20%) or use microencapsulated extract, add to aqueous phase (≤40°C);

3. Process nodes: Late emulsification stage, batching stage; avoid high temperature (>50°C) to prevent active degradation.

- Recommended dosage: Skin care 0.05%–0.3%; shampoo 0.1%–0.5%; mask serum 0.05%–0.2%.

(2) Garlic Extract Microemulsion / Nanoemulsion (Water-Soluble, Easily Absorbed)

- Applications: Essences, toners, masks, body washes.
- Addition methods: Directly add to aqueous phase and stir evenly; no cosolvent required, high stability.
- Recommended dosage: Same as water-soluble extract; higher bioavailability of microemulsion allows 20%–30% dosage reduction.

5.3 Operation Points & Quality Control

1. Irritation control: Cosmetic-grade extracts shall have pungent components removed or used at low concentration (≤0.3%) to avoid mucosal irritation.
2. Compatibility safety: Avoid direct mixing with high-concentration vitamin C and fruit acids to prevent oxidative decomposition; compound with hyaluronic acid and ceramides to enhance efficacy.
3. Stability: Add antioxidants (vitamin E, BHT), store sealed and protected from light to prevent oxidation of active ingredients.
4. Compliance: Conform to the *Safety and Technical Specifications for Cosmetics*; tested for heavy metals, microorganisms, irritation, free of prohibited ingredients.
5. Efficacy verification: Complete in vitro antibacterial, antioxidant and cytotoxicity tests to ensure safety and effectiveness.

VI. Agricultural Application Addition Operation Guide

6.1 Applicable Scenarios & Core Functions

- Pesticides: Control bacterial diseases (citrus canker, cucumber angular leaf spot, rice bacterial streak), fungal diseases; natural bacteriostat.
- Fertilizer/soil treatment: Soil improvement, inhibition of soil-borne diseases, root growth promotion, crop stress resistance enhancement.
- Seed treatment: Sterilization, germination promotion, emergence rate improvement.

6.2 Dosage Form Selection & Addition Methods

(1) Garlic Extract Microemulsion (5%, T/CAPDA 012-2021)

- Applications: Foliar spray, root irrigation, soil treatment.
- Addition methods:
    1. Foliar spray: Dilute 600–1000 times, spray at early onset, evenly cover leaf backs and stems, apply 2–3 times at 7–10 day intervals;
    2. Root irrigation: Dilute 400–800 times, irrigate 500–1000 ml per plant to control bacterial wilt and root rot;
    3. Soil treatment: Dilute 300–500 times, apply with irrigation water or mix with soil and broadcast, dosage 40–50 ml/mu.
- Recommended dosage: Foliar spray 40–50 ml/mu of 5% microemulsion; slightly higher for root irrigation.

(2) Garlic Extract Powder / Granules

- Applications: Soil treatment, seed dressing.
- Addition methods:
    1. Seed dressing: Mix powder with seeds at 1:50 to 1:100, air-dry before sowing;
    2. Soil broadcasting: Mix granules with fine soil, broadcast evenly and tillage, dosage 1–2 kg/mu.
- Recommended dosage: Seed dressing 0.5%–1%; soil broadcasting 1–2 kg/mu.

6.3 Operation Points & Quality Control

1. Application timing: Prevention-oriented, apply at early onset; avoid application under high temperature (>35°C) and strong light; best in early morning or evening.
2. Synergistic compounding: Compound with kasugamycin and copper preparations to reduce chemical pesticide dosage by 30%–50% and improve control effect by over 20%.
3. Pre-harvest interval: 7–10 days for vegetables, 15 days for fruit trees to avoid excessive residue.
4. Compliance: Use registered pesticide-grade garlic extract conforming to the *Regulations on Pesticide Administration*, and keep registration certificates and inspection reports.

VII. Industrial Application Addition Operation Guide

7.1 Applicable Scenarios & Core Functions

- Water treatment: Anti-theft of heating network water (garlic-scented odorant), sterilization and algae removal, microbial growth inhibition.
- Leather/paper/textile: Anti-mold, antiseptic, antibacterial, product shelf life extension.
- Coatings/plastics: Natural antioxidation and antibacterial, improved weather resistance.

7.2 Dosage Form Selection & Addition Methods

(1) Garlic-Scented Odorant (Garlic Extract-Based, Water Treatment Special)

- Applications: Hot water boilers, heating networks, industrial circulating water.
- Addition methods: 30–100 g per ton of water, dissolve in warm water and add to the system in one dose; supplement proportionally during makeup water addition.
- Operation points: Sealed operation to avoid direct inhalation; store in cool, ventilated area to prevent leakage.

(2) Garlic Extract Preservative Solution (Oil-Soluble/Water-Soluble)

- Applications: Leather tanning, paper pulp, textile dyeing, coating formulations.
- Addition methods:
    1. Leather: Add to tanning solution, dosage 0.1%–0.5%, soak for 24–48 hours;
    2. Paper making: Add to pulp, dosage 0.1%–1%, stir evenly before papermaking;
    3. Coatings: Add to formula, dosage 0.1%–0.5%, mix at room temperature.
- Recommended dosage: Leather 0.1%–0.5%; paper making 0.1%–1%; coatings 0.1%–0.5%.

(3) Garlic Extract Antioxidant (Powder/Oily)

- Applications: Plastics, rubber, grease industry.
- Addition methods: Premix with raw materials, add during extrusion/injection molding, dosage 0.01%–0.5%.

7.3 Operation Points & Quality Control

1. Concentration control: Precisely add per process requirements to avoid odor residue or cost increase from overdosage.
2. Equipment protection: Use stainless steel or plastic equipment; avoid contact with Cu, Fe and other metals to prevent oxidation.
3. Environmental requirements: Industrial wastewater discharged after treatment in compliance with environmental standards.

VIII. Storage & Transportation Specifications

1. Storage conditions: Sealed, protected from light, cool and dry area, temperature ≤25°C; garlic oil/allicin refrigerated at 2–8°C, shelf life 6–12 months; stabilized extracts stored at room temperature, shelf life 12–24 months.
2. Packaging requirements: Oily extracts packed in fluorinated drums or aluminum cans; powders packed in aluminum foil bags or fiber drums lined with polyethylene bags for moisture and leak prevention.
3. Transportation requirements: Avoid exposure, rain and high temperature; garlic oil is flammable liquid, transported in accordance with dangerous goods regulations.
4. Batch management: Each batch marked with production date, shelf life, active content and batch number; first-in first-out.

IX. Quality Inspection & Abnormality Handling

9.1 Mandatory Inspection Items

- Content detection: Allicin (GC), alliin (HPLC), S-allylcysteine (HPLC).
- Physicochemical indexes: Moisture, ash, pH, solubility, heavy metals (Pb, As, Hg), solvent residues.
- Microbial indexes: Total plate count, mold, yeast, pathogenic bacteria (food/medicine/cosmetics).
- Stability: Accelerated test (40°C, 75% RH), detection of active ingredient retention rate.

9.2 Abnormality Handling

1. Active ingredient degradation: Causes (high temperature, light, inappropriate pH); solutions (adjust addition temperature, light protection, pH adjustment, switch to stabilized dosage form).
2. Poor uniformity: Causes (no premixing, improper dilution); solutions (stepwise dilution, extended stirring time, use of emulsifiers).

3. Excessive odor/irritation: Causes (overdosage, no flavor masking); solutions (dosage reduction, microencapsulation, compounding with other flavors).
4. Compatibility failure: Causes (mixing with incompatible substances); solutions (adjust formula sequence, separate addition, replace compatible ingredients).

X. Supplementary Provisions

1. This Guide is a professional operation specification; enterprises may optimize and adjust according to their product characteristics, process equipment and regulatory requirements.
2. Garlic extract dosage shall be verified through laboratory and pilot tests to determine optimal process parameters before large-scale production.
3. Matters not covered herein shall be implemented in accordance with relevant national standards, regulations and manufacturer’s product instructions.