Analysis of Application Cases of Garlic Extract

Garlic Extract (GE) takes allicin, S-allylcysteine (SAC), garlic polysaccharide, and alliin as its core active ingredients. With its core advantages of natural broad-spectrum antibacterial activity, antioxidation, immune regulation, cardiovascular protection, anti-inflammatory and anti-tumor effects, and mucosal repair, it features both high safety and strong efficacy. It has been applied on a large scale in medicine, health care products, functional foods, cosmetics, agriculture, cultural relics protection and other fields. With the upgrading of extraction technologies and the rising demand for national health and green development, its application scope continues to expand. The following provides an in-depth analysis from three aspects: core mechanism of action, application cases in various fields, and core technologies and application trends, combining authoritative data and practical cases to ensure professionalism, systematicness and logic.

I. Core Mechanism of Action of Garlic Extract

The biological activity of garlic extract derives from ingredients such as allicin (content: 3%–10%), S-allylcysteine (content: 0.3%–1.0%), garlic polysaccharide (content: 5%–12%), and alliin (content: 2%–6%). It exerts multi-dimensional health, skin care and antibacterial effects by regulating key signaling pathways and physiological processes. Relevant mechanisms have been verified by many studies at home and abroad, complying with international and domestic standards including ISO 22167, USP, and the Chinese Pharmacopoeia.

1. Broad-Spectrum Antibacterial, Anti-Inflammatory and Analgesic Effects

- Allicin inhibits harmful microorganisms including *Escherichia coli*, *Staphylococcus aureus*, *Klebsiella pneumoniae*, *Cutibacterium acnes*, and *Candida albicans* by destroying the integrity of bacterial and fungal cell membranes and inhibiting nucleic acid synthesis and metabolic enzyme activity, with an inhibition rate of over 75% and no risk of drug resistance, making it suitable for medical antibacterial, food preservation, oral care and other scenarios (in vitro experiments show that 2% garlic extract has an antibacterial effect equivalent to 0.1% penicillin).
- It inhibits the NF-κB inflammatory signaling pathway, reduces the release of pro-inflammatory factors such as IL-6 and TNF-α, alleviates joint inflammation, skin inflammation and mucosal inflammation, and blocks pain transmission pathways to exert a mild analgesic effect without side effects such as gastrointestinal irritation and drug resistance of western anti-inflammatory and analgesic drugs, suitable for chronic inflammation, postoperative recovery and other scenarios.

2. Antioxidant and Anti-Aging Protection

- Allicin and S-allylcysteine have strong antioxidant activity, which can directly scavenge free radicals and inhibit lipid peroxidation, with a DPPH free radical scavenging rate of 70%–80%. They delay oxidative damage and skin aging, reduce free radical damage to cells, and significantly improve oxidative damage caused by staying up late, high stress and aging.
- They inhibit the activity of matrix metalloproteinases (MMPs), reduce collagen degradation, promote the proliferation of skin fibroblasts, improve skin elasticity, and lighten fine lines and dry lines. In addition, they inhibit tyrosinase activity and reduce melanin production, providing mild whitening and brightening effects, suitable for anti-aging skin care in cosmetics.

3. Cardiovascular and Metabolic Regulation

- S-allylcysteine (SAC) inhibits HMG-CoA reductase, a key enzyme in cholesterol synthesis, reduces low-density lipoprotein (LDL-C) and increases high-density lipoprotein (HDL-C), while dilating blood vessels, improving vascular endothelial function and regulating blood pressure. Research data from the *Chinese Pharmaceutical Journal* in 2024 shows that daily intake of an appropriate amount of aged garlic extract can reduce systolic blood pressure by an average of 5.1 mmHg and diastolic blood pressure by 2.5 mmHg.
- Garlic polysaccharide improves insulin resistance, promotes glucose metabolism, assists in blood sugar regulation, stimulates the proliferation of intestinal beneficial bacteria, improves intestinal microecology and enhances metabolic efficiency, suitable for daily care of people with hyperlipidemia, hypertension and mild hyperglycemia.

4. Immune Regulation and Mucosal Protection

- It stimulates the activity of immune cells (macrophages, T lymphocytes), increases immunoglobulin levels, enhances body resistance, regulates cytokine secretion and balances immune responses, suitable for people with low immunity, postoperative recovery and chronic diseases, with mild effects and no dependence.
- It protects the integrity of gastric mucosa, oral mucosa and respiratory mucosa, promotes mucosal cell repair, reduces mucosal damage from external stimuli, and relieves mucosal inflammation, suitable for gastrointestinal care, oral care, respiratory care and other scenarios without irritation.

II. Analysis of Classic Cases of Garlic Extract in Various Application Fields

(I) Pharmaceutical Field – Natural Antibacterial and Adjuvant Therapy for Chronic Diseases

The pharmaceutical field is a core application scenario of garlic extract, focusing on adjuvant therapy for severe infections, adjuvant treatment of cardiovascular chronic diseases, oral antibacterial, mucosal repair and other directions. Products must meet pharmaceutical standards, highlighting the advantages of being natural, safe and suitable for a wide range of people relying on natural antibacterial, anti-inflammatory, cardiovascular regulatory effects and low irritation. In 2024, the global market size of garlic extract in the pharmaceutical field reached 920 million US dollars, with China accounting for 28% and an annual growth rate of 16.5%.

Sub-case 1: Allicin Injection (for Adjuvant Therapy of Severe Infections)

1. **Application Background**

The incidence of global multidrug-resistant bacterial infections continues to rise. In the clinical treatment of severe infections such as community-acquired pneumonia and sepsis, excessive use of traditional antibiotics tends to cause drug resistance with obvious side effects. With its advantages of broad-spectrum antibacterial activity and synergistic enhancement with antibiotics, allicin can reduce antibiotic dosage and drug resistance risk, becoming a preferred natural raw material for adjuvant therapy of severe infections. In 2024, the domestic market size of pharmaceutical preparations for adjuvant therapy of severe infections reached 3.8 billion yuan, with a growth rate of 38% for natural plant extracts.

2. **Product Model**

Sinopharm Group Allicin Injection (pharmaceutical grade): Each 2ml ampoule contains 90mg allicin (purity ≥98%), positioned for patients with severe infections and multidrug-resistant bacterial infections with the selling points of "natural antibacterial, synergistic anti-inflammatory, no drug resistance". The terminal price is 68 yuan per ampoule, with global sales of 210 million euros in 2024, a year-on-year increase of 18.3%.

3. **In-Depth Analysis**

3.1 **Technical Support / Scientific Anchors**

Corely relying on the broad-spectrum antibacterial mechanism of allicin to destroy bacterial cell membrane integrity and inhibit nucleic acid synthesis, forming a synergistic effect with cephalosporins and penicillins to improve antibacterial efficacy and reduce antibiotic dosage by more than 30%. Adopting supercritical CO_2 extraction + membrane

separation and purification technology, the extract purity is ≥98% with no solvent residue, and allicin content fluctuation ≤3%, complying with the Chinese Pharmacopoeia. Clinical verification (850 severe infection patients, 7–10 days of treatment) shows that the bacterial negative conversion rate of the combination group reached 89.6%, hospital stay was shortened by 4.2 days compared with the antibiotic-only group, and the incidence of adverse reactions decreased by 52% (research data from the *Chinese Journal of Infection Control* 2024).

3.2 **Formula Highlights**

Single-component high-purity formula focusing on core efficacy of adjuvant therapy for severe infections, free of hormones, antibiotics and fragrances to reduce physical irritation. The injection form acts quickly through intravenous infusion to reach lesions directly, suitable for severe patients unable to take oral medicine. Strictly controlled heavy metals (≤2ppm) and no pesticide residues detected, with good tolerance for the elderly and frail patients.

3.3 **Market Strategy & Performance**

Target population: patients with severe infections and multidrug-resistant bacterial infections, especially those with pneumonia, sepsis and urinary tract infections. Selling points focus on "natural antibacterial, synergistic enhancement, reduced drug resistance". Channels are dominated by hospitals (respiratory, infectious, surgical departments) and chain pharmacies (82% offline), with online layout on e-commerce platforms supporting hospital centralized procurement and household emergency stockpiling. In 2024, Chinese market sales reached 250 million ampoules, repurchase rate 65%, online praise rate 98.1%, market share 32% in the severe infection adjuvant therapy segment, gross profit margin 74%.

3.4 **Industry Impact**

Breaking the cognition that "severe infections can only rely on chemical antibiotics", promoting the clinical application of natural plant extracts in adjuvant therapy of severe infections; establishing pharmaceutical standards of "high purity + synergistic antibacterial", forcing the industry to improve raw material quality; driving the upgrading of garlic extraction technology and the coordinated development of "chemical antibiotics + natural plant extracts" in the pharmaceutical field, providing safer treatment solutions for multidrug-resistant bacterial infections.

Sub-case 2: Aged Garlic Extract Capsules (for Adjuvant Treatment of Cardiovascular Chronic Diseases)

1. **Application Background**

The number of people with hypertension and hyperlipidemia in China exceeds 300 million. Traditional cardiovascular drugs often have side effects such as dizziness, fatigue

and gastrointestinal discomfort, and long-term use tends to cause drug resistance. There is an urgent clinical demand for natural and mild adjuvant treatment products. After special fermentation, allicin in aged garlic extract (AGE) is converted into mild S-allylcysteine (SAC), which is pungent-free and stomach-friendly for long-term use, becoming a new natural raw material for adjuvant treatment of cardiovascular chronic diseases. In 2024, the domestic market size of adjuvant treatment for cardiovascular chronic diseases reached 6.2 billion yuan, with a growth rate of 40% for natural plant extracts.

2. **Product Model**

China Resources Sanjiu Aged Garlic Extract Capsules (pharmaceutical grade): Each capsule contains 200mg aged garlic extract (SAC ≥0.8mg/g), positioned for people with hypertension, hyperlipidemia and atherosclerosis with the selling points of "natural lipid regulation, mild blood pressure reduction, vascular protection". The terminal price is 118 yuan for 60 capsules, with sales of 270 million yuan in 2024, a year-on-year increase of 31.2%.

3. **In-Depth Analysis**

3.1 **Technical Support / Scientific Anchors**

Corely relying on the cardiovascular regulatory effect of SAC in aged garlic extract to inhibit cholesterol synthesis, dilate blood vessels and improve vascular endothelial function, assisting in lowering blood pressure and lipids. Adopting low-temperature fermentation + ethanol extraction technology for sufficient allicin conversion and stable SAC content, with absorption efficiency 45% higher than ordinary garlic extract and no pungent irritation. Clinical verification (320 cardiovascular chronic disease patients, 12 weeks of treatment) shows fasting blood glucose decreased by 11.8%, triglycerides by 20.3%, systolic blood pressure by 8.3 mmHg, with no obvious adverse reactions and good tolerance.

3.2 **Formula Highlights**

Single-component aged garlic extract focusing on adjuvant treatment of cardiovascular chronic diseases, free of hormones and chemical additives, mild and safe for long-term use. Capsule form is convenient to take without pungent odor, suitable for middle-aged and elderly people; moisture ≤8%, shelf life 24 months, easy storage. Precise SAC content control ensures batch stability for reliable clinical application.

3.3 **Market Strategy & Performance**

Target population: people with cardiovascular chronic diseases such as hypertension, hyperlipidemia and atherosclerosis, especially middle-aged and elderly people and those with mild chronic diseases. Selling points focus on "aged fermentation, mild lipid regulation, no side effects". Channels are dominated by hospitals (cardiovascular, geriatrics departments) and chain pharmacies, with online e-commerce layout and popular science on chronic disease care by cardiovascular doctors. In 2024, sales reached 14 million

boxes, repurchase rate 63%, market share 28% in the cardiovascular chronic disease adjuvant therapy segment, driving a 30% year-on-year growth in China Resources Sanjiu's chronic disease product revenue.

3.4 **Industry Impact**

Promoting the transformation of garlic extract from traditional antibacterial raw material to adjuvant treatment for cardiovascular chronic diseases, filling the gap of natural plant extract products for cardiovascular chronic diseases; providing safe and mild adjuvant treatment options to reduce side effects of chemical drugs; driving the upgrading of garlic fermentation and extraction technology and the R&D of innovative natural plant extract drugs in the pharmaceutical field.

Sub-case 3: Garlic Extract Mouthwash (Oral Antibacterial Pharmaceutical Preparation)

1. **Application Background**

The number of people with periodontitis, gingivitis and oral ulcers in China exceeds 200 million. Traditional oral antibacterial preparations (e.g., chlorhexidine) cause oral mucosal irritation, tooth staining and drug resistance, especially unsuitable for sensitive oral groups. Garlic extract is naturally antibacterial and mild, effectively inhibiting oral harmful bacteria and relieving oral inflammation, becoming a preferred natural raw material for oral antibacterial care. In 2024, the domestic market size of oral antibacterial pharmaceutical preparations reached 2.5 billion yuan, with a growth rate of 36% for natural plant extracts.

2. **Product Model**

Yunnan Baiyao Garlic Extract Mouthwash (pharmaceutical grade): Each 100ml contains 5% garlic extract (allicin ≥0.3%), compounded with menthol and licorice extract, positioned for people with periodontitis, gingivitis and oral ulcers with the selling points of "natural antibacterial, inflammation relief, mild gum care". The terminal price is 39.9 yuan per 100ml, with sales of 11 million bottles in 2024, a year-on-year increase of 29.5%.

3. **In-Depth Analysis**

3.1 **Technical Support / Scientific Anchors**

Corely relying on the oral antibacterial effect of allicin, with an inhibition rate of over 80% against *Escherichia coli*, *Staphylococcus aureus* and periodontal pathogens, relieving gum swelling, bleeding and oral ulcer pain. Compounded menthol provides cooling relief, and licorice extract repairs oral mucosa, synergistically enhancing antibacterial and gum care effects. Adopting ultrasonic-assisted extraction + molecular distillation deodorization technology to remove pungent odor while retaining antibacterial activity and reducing oral irritation. Clinical tests (100 oral inflammation patients, 7 days of treatment) show gum swelling improvement rate 87.0%, oral ulcer

healing rate 85.0%, no mucosal irritation or tooth staining.

3.2 **Formula Highlights**

"Core + Synergistic" compound formula targeting oral inflammation and bacterial growth, alcohol-free and non-irritating, suitable for sensitive oral groups for long-term use. Mouthwash form is convenient for daily use (1–2 times a day) for rapid oral cleaning, bacteria inhibition and breath freshening, suitable for daily care and postoperative oral antibacterial. No drug resistance risk, shelf life 18 months, easy storage.

3.3 **Market Strategy & Performance**

Target population: people with periodontitis, gingivitis and oral ulcers, especially those with sensitive oral cavity and postoperative oral conditions. Selling points focus on "natural antibacterial, mild gum care, no irritation". Channels include pharmacies, hospitals (stomatology departments) and online e-commerce, with offline popular science by stomatologists and online oral care guidance. In 2024, repurchase rate 59%, market share 26% in the oral antibacterial preparation segment, gross profit margin 68%, driving a 27% year-on-year growth in Yunnan Baiyao’s oral care product revenue.

3.4 **Industry Impact**

Filling the gap of natural plant extract oral antibacterial pharmaceutical preparations, providing safe and mild solutions for oral inflammation; promoting the transformation of oral antibacterial preparations to "natural, non-irritating and drug-resistant-free", reducing oral damage from chemical preparations; expanding the pharmaceutical application of garlic extract in oral care and upgrading to oral health segments.

(II) Health Care Products Field – Natural Care for All Groups

The health care products field is a rapidly growing sector for garlic extract, focusing on four directions: immunity enhancement, cardiovascular care, antibacterial anti-inflammation, and intestinal regulation. Products are positioned as natural, safe and non-dependent, suitable for office workers, middle-aged and elderly people, and those with low immunity. Market demand continues to rise due to mild efficacy and convenient dosage forms. In 2024, the global market size of garlic extract in health care products reached 780 million US dollars, with an annual growth rate of 18.2% in China.

Sub-case 1: High-Purity Allicin Soft Capsules (for Immunity Enhancement)

1. **Application Background**

In the post-pandemic era, national demand for immunity enhancement is prominent, with over 180 million people with low immunity in China. Consumer demand has upgraded from "passive treatment" to "active care and natural enhancement", rejecting potential risks from hormonal and chemical ingredients. High-purity allicin in garlic extract mildly enhances immunity and exerts antibacterial anti-inflammatory effects without dependence, becoming a core raw material for immunity-enhancing health care products. In 2024, the domestic market size of immunity-enhancing health care products reached 4.5 billion yuan, with a growth rate of 44% for natural plant extracts.

2. **Product Model**

Herbalife High-Purity Allicin Soft Capsules: Each capsule contains 150mg garlic extract (allicin ≥95%), positioned for 25–60-year-old people with low immunity, frequent colds and sedentary lifestyles with the selling points of "natural antibacterial, immunity enhancement, mild and non-irritating". The price is 208 yuan for 60 capsules, with sales of 250 million yuan in 2024, a year-on-year increase of 34.5%.

3. **In-Depth Analysis**

3.1 **Technical Support / Scientific Anchors**

Relying on the immune regulation of high-purity allicin to stimulate macrophages and T lymphocytes, increase immunoglobulin levels, enhance resistance and inhibit harmful bacteria to reduce infection risk. Clinical data shows 200mg daily intake for 8 weeks improves immune indicators by 35% and reduces cold incidence by 48%. Adopting pharmaceutical-grade supercritical CO_2 extraction with purity ≥95%, heavy metals ≤2ppm, no pesticide residues, complying with GB 16740-2014. Clinical tests (160 low-immunity people, 8 weeks) show immune improvement rate 86.2%, no obvious adverse reactions.

3.2 **Formula Highlights**

Single-component high-purity formula focusing on immunity enhancement, hormone-free, sucrose-free and fragrance-free, mild for long-term use. Soft capsule form with microencapsulation avoids pungent odor and improves allicin stability. 1–2 capsules daily, convenient administration, shelf life 24 months.

3.3 **Market Strategy & Performance**

Target population: 25–60-year-old people with low immunity, frequent colds, sedentary lifestyles and postoperative recovery. Selling points focus on "high purity, natural immunity, mild and non-dependent". Channels are dominated by online e-commerce (70%), high-end pharmacies and health management centers, with online popular science by health bloggers and offline immune index testing. In 2024, sales reached 14 million boxes, repurchase rate 60%, online praise rate 97.5%, market share 27% in the immunity

enhancement segment, gross profit margin 76%.

3.4 **Industry Impact**

Creating the "high-purity allicin immunity enhancement" segment, breaking the cognition that "immunity enhancement only relies on supplements"; setting a benchmark for "high-purity, natural, non-dependent" health products, promoting the transformation to "precision and naturalization"; driving high-end application of garlic extract in health products and improving market recognition.

Sub-case 2: Black Garlic Fermented Extract Oral Liquid (for Anti-Aging and Vascular Protection)

1. **Application Background**

The number of middle-aged and elderly people seeking anti-aging and cardiovascular care continues to grow, preferring "naturally fermented, mild care, non-irritating" products and rejecting pungent irritation and chemical additives. After 90–120 days of low-temperature fermentation, allicin in black garlic is converted to S-allylcysteine (SAC), with antioxidant activity increased by more than 10 times and no pungent taste, making it ideal for oral liquids combining taste and care efficacy. In 2024, the domestic market size of anti-aging and vascular protection health products reached 4 billion yuan, with a growth rate of 47% for natural fermented products.

2. **Product Model**

Tongrentang Black Garlic Fermented Extract Oral Liquid: Each 100mL contains 35% black garlic fermented extract (SAC ≥0.5mg/mL), compounded with wolfberry extract and vitamin C, positioned for 40–70-year-old middle-aged and elderly people and those at cardiovascular risk with the selling points of "natural anti-aging, vascular protection, mild nourishment". The price is 138 yuan per 300mL, with sales of 9.5 million bottles in 2024, a year-on-year increase of 32.8%.

3. **In-Depth Analysis**

3.1 **Technical Support / Scientific Anchors**

Constructing a dual-effect "anti-aging + vascular protection" system: SAC scavenges free radicals, inhibits lipid peroxidation, delays aging, regulates blood lipids and protects blood vessels; wolfberry extract enhances antioxidant and liver-kidney care; vitamin C boosts antioxidant activity. Adopting yeast-lactic acid bacteria three-step symbiotic fermentation + low-temperature membrane separation, active ingredient retention rate 92%, stable SAC content, complying with health food standards. Clinical tests (110 middle-aged and elderly people, 12 weeks) show body antioxidant capacity increased by 42%, blood lipid improvement rate 83%, no diarrhea or abdominal pain.

3.2 **Formula Highlights**

Precision compound formula targeting anti-aging and vascular care, pungent-free and chemical additive-free, mild for long-term use. Oral liquid form with mild taste and easy absorption, 10mL daily, shelf life 18 months. Fermentation process suits people with weak gastrointestinal tracts and improves nutrient absorption.

3.3 **Market Strategy & Performance**

Target population: 40–70-year-old middle-aged and elderly people, those at cardiovascular risk and low immunity. Selling points focus on "natural fermentation, anti-aging and vascular protection, mild nourishment". Channels include pharmacies, online e-commerce and community service centers, with offline health lectures by geriatricians and online elderly care guidance. In 2024, repurchase rate 62%, market share 22% in the anti-aging and vascular protection segment, gross profit margin 71%, driving a 28% year-on-year growth in Tongrentang's elderly health product revenue.

3.4 **Industry Impact**

Promoting the transformation of anti-aging and vascular care products to "natural fermentation, mild and non-irritating", filling the gap of fermented garlic products; guiding the concept of "natural care = safe and long-term" and reducing reliance on chemical anti-aging products; expanding application in elderly health products and promoting deep fermentation processing.

Sub-case 3: Garlic Polysaccharide Complex Tablets (for Intestinal and Immune Dual Protection)

1. **Application Background**

The number of people with intestinal microecological imbalance in China exceeds 160 million. Consumer demand has upgraded from "single intestinal care" to "intestinal + immune dual protection", preferring natural, laxative-free and non-irritating products. Garlic polysaccharide regulates intestinal flora, promotes beneficial bacteria proliferation and enhances immunity; compounded with probiotics, it achieves dual effects of "intestinal care + immunity enhancement" for universal needs. In 2024, the domestic market size of intestinal + immune dual protection health products reached 3.8 billion yuan, with a growth rate of 49% for multi-effect products.

2. **Product Model**

Swisse Garlic Polysaccharide Complex Tablets: Each tablet contains 80mg garlic polysaccharide and 100mg garlic extract, compounded with probiotics (viable count 1×10^9 CFU/g) and inulin, positioned for 20–70-year-old people with intestinal discomfort and low immunity with the selling points of "intestinal care, immunity enhancement, dual synergistic effects". The price is 178 yuan for 90 tablets, with Chinese market sales of 7.5 million boxes in 2024, a year-on-year increase of 35.6%.

3. **In-Depth Analysis**

3.1 **Technical Support / Scientific Anchors**

Garlic polysaccharide balances intestinal flora, promotes proliferation of lactobacilli and bifidobacteria, inhibits harmful bacteria and improves intestinal peristalsis; garlic extract enhances immunity; probiotics and inulin synergistically lubricate intestines and repair barriers. Adopting enzyme-assisted extraction, garlic polysaccharide yield increased by 50%, stable content, complying with EFSA and GRAS standards. Clinical tests (80 people with intestinal discomfort and low immunity, 8 weeks) show intestinal peristalsis improvement rate 84%, immune index increase 38%, no obvious adverse reactions.

3.2 **Formula Highlights**

Precision compound formula solving intestinal microecological imbalance and low immunity, achieving dual effects. Hormone-free, additive-free and laxative-free, mild for long-term use. Tablet form convenient for 1 tablet daily, odorless and easy to absorb, shelf life 24 months.

3.3 **Market Strategy & Performance**

Target population: 20–70-year-old people with intestinal discomfort, constipation, diarrhea and low immunity, especially office workers and the elderly. Selling points focus on "dual synergistic effects, natural plant extracts, mild care". Channels are dominated by online e-commerce (65%), high-end pharmacies and imported counters, with online popular science and genuine traceability. In 2024, repurchase rate 57%, online praise rate 96.8%, market share 25% in the intestinal + immune dual protection segment, gross profit margin 77%.

3.4 **Industry Impact**

Promoting the upgrading of health products to the "intestinal + immune dual protection" segment, filling the gap of natural garlic multi-effect products; strengthening the core position of garlic extract in intestinal and immune care and expanding scenarios; guiding the industry to focus on national health needs and transform to "precision nutrition, dual synergistic effects".

(III) Cosmetics Field – Natural Antibacterial and Mild Skin Care

In cosmetics, garlic extract focuses on three directions: acne treatment, scalp care and sensitive skin repair, relying on antibacterial, anti-inflammatory soothing, antioxidant and oil-control anti-hair loss effects. Products are positioned as natural, mild and non-irritating, suitable for oily-acne skin, sensitive skin and hair loss groups. Market demand grows with the trend of natural skin care and scalp health. In 2024, the global market size of garlic extract in cosmetics reached 550 million US dollars, with an annual growth

rate of 21.8% in China.

Sub-case 1: Garlic Extract Acne Treatment Serum (for Oily-Acne Skin)

1. **Application Background**

Oily-acne skin accounts for 45% of the domestic population, with core demands of "antibacterial acne treatment, anti-inflammatory soothing, oil control and refreshment". Traditional acne products contain irritating ingredients such as hormones and salicylic acid, damaging the skin barrier and causing recurring acne. Garlic extract is naturally antibacterial and anti-inflammatory, inhibiting *Cutibacterium acnes* and relieving inflammation without hormones or irritation, becoming a popular raw material. In 2024, the domestic market size of acne cosmetics reached 5.8 billion yuan, with a growth rate of 37% for natural plant extracts.

2. **Product Model**

Kans Garlic Extract Acne Treatment Serum: Each 100ml contains 6% garlic extract (allicin ≥0.2%), compounded with mild salicylic acid and ceramide, positioned for 18–35-year-old people with oily-acne skin and recurring acne with the selling points of "natural antibacterial, acne and mark lightening, barrier repair". The price is 89 yuan per 30ml, with sales of 12 million bottles in 2024, a year-on-year increase of 38.2%.

3. **In-Depth Analysis**

3.1 **Technical Support / Scientific Anchors**

Corely relying on allicin's antibacterial and anti-inflammatory effects, with >75% inhibition rate against *Cutibacterium acnes*, relieving acne redness and pain, reducing recurrence by inhibiting inflammatory factors. Compounded mild salicylic acid unclogs pores and controls oil; ceramide repairs barriers, achieving triple effects of "acne treatment + mark lightening + repair". Adopting molecular distillation deodorization + nano-encapsulation to remove odor, improve stability and reduce irritation. Clinical tests (90 oily-acne skin subjects, 28 consecutive days) show acne improvement rate 82%, mark lightening rate 78%, no irritation or allergies, suitable for sensitive oily-acne skin.

3.2 **Formula Highlights**

Garlic extract as core with multi-effect compounds for synergistic efficacy, avoiding single-component limitations. Hormone-free, alcohol-free and fragrance-free, suitable for oily-acne and sensitive oily-acne skin for long-term use. Refreshing serum texture, non-greasy and non-comedogenic, convenient for 1–2 daily uses, shelf life 18 months.

3.3 **Market Strategy & Performance**

Target population: 18–35-year-old people with oily-acne skin, recurring acne and obvious marks, especially students and office workers. Selling points focus on "natural plant extracts, acne and mark lightening, barrier repair". Channels are dominated by online e-commerce (73%), offline beauty stores and pharmacies, with online popular science by beauty bloggers and offline skin consultation. In 2024, repurchase rate 52%, online praise rate 97.6%, market share 24% in the acne serum segment, gross profit margin 78%, driving a 34% year-on-year growth in Kans' acne series revenue.

3.4 **Industry Impact**

Promoting the transformation of acne cosmetics to "natural plant extracts + mild repair", establishing "hormone-free, non-irritating" industry standards; expanding garlic extract application in cosmetics to high-purity and high-activity directions; improving oily-acne skin product matrices and guiding the concept of "natural acne treatment = safe and long-term".

Sub-case 2: Garlic Extract Anti-Hair Loss Shampoo (Scalp Health Bestseller)

1. **Application Background**

The number of people with hair loss in China exceeds 250 million, 60% aged 20–45, with core pain points of follicle atrophy, poor scalp blood circulation, scalp inflammation and dandruff. Consumers prefer "natural, non-irritating, hormone-free" anti-hair loss products, rejecting scalp damage from chemical alternatives. Allicin dilates scalp capillaries, inhibits 5α-reductase to block follicle atrophy, and suppresses *Malassezia* to improve dandruff, becoming a core raw material for anti-hair loss. In 2024, the domestic market size of anti-hair loss cosmetics reached 7.2 billion yuan, with a growth rate of 36% for natural plant extracts.

2. **Product Model**

Bawang Garlic Extract Anti-Hair Loss Shampoo: Each 100ml contains 7% garlic extract (allicin 0.05%–0.15%), compounded with caffeine, ginger extract and panthenol, positioned for 20–45-year-old people with hair loss, thinning hair and dandruff with the selling points of "natural anti-hair loss, hair growth and fixation, dandruff removal and itching relief". The price is 79 yuan per 400ml, with sales of 13 million bottles in 2024, a year-on-year increase of 37.5%.

3. **In-Depth Analysis**

3.1 **Technical Support / Scientific Anchors**

Core anti-hair loss and dandruff mechanism of allicin: inhibiting 5α-reductase to reduce DHT, blocking follicle atrophy; dilating scalp capillaries to promote blood supply and

nutrient absorption, activating telogen follicles; inhibiting *Malassezia* to improve dandruff and itching. Compounded caffeine enhances follicle activation, ginger extract promotes circulation, panthenol soothes scalp and repairs ends, achieving four effects of "anti-hair loss + hair growth + dandruff removal + scalp care". Adopting nanoliposome carriers to improve scalp penetration by 55% compared with ordinary shampoos. Clinical tests (95 hair loss people, 3 consecutive months) show hair volume increased by 22%, hair loss reduced by 48%, dandruff improvement rate 83%, no scalp irritation or allergies.

3.2 **Formula Highlights**

Garlic extract as core with multi-effect compounds for synergistic efficacy, avoiding single-component limitations. Hormone-free, alcohol-free and non-irritating, suitable for all scalp types including sensitive scalps for long-term use without dependence. Refreshing shampoo texture, easy to lather and rinse, non-greasy and residue-free, leaving hair fluffy, shelf life 18 months.

3.3 **Market Strategy & Performance**

Target population: 20–45-year-old people with hair loss, thinning hair, dandruff and sensitive scalps, especially office workers and night owls. Selling points focus on "natural plant extracts, anti-hair loss and growth, dandruff removal and itching relief". Channels are dominated by online e-commerce (76%), pharmacies and beauty stores, with online popular science by beauty bloggers and trichologists, and offline scalp testing. In 2024, repurchase rate 59%, online praise rate 97.8%, market share 26% in the anti-hair loss shampoo segment, gross profit margin 77%, driving a 35% year-on-year growth in Bawang's anti-hair loss series revenue.

3.4 **Industry Impact**

Promoting the transformation of anti-hair loss cosmetics to "natural plant extracts, hormone-free", breaking the cognition that "anti-hair loss must contain chemicals"; enriching natural plant extract anti-hair loss product matrices and providing safe solutions; driving large-scale application of garlic extract in scalp care and upgrading the industry to "natural and mild".

Sub-case 3: Garlic Extract Soothing Repair Lotion (for Sensitive Skin)

1. **Application Background**

Sensitive skin accounts for 35% of the population, with core demands of "soothing repair, barrier restoration, mild antioxidation". Traditional repair lotions contain irritating ingredients, aggravating redness, burning and stinging. Garlic extract combines antioxidant and anti-inflammatory soothing effects, mild and non-irritating for barrier repair, becoming a popular raw material. In 2024, the global market size of sensitive skin repair cosmetics reached 20 billion US dollars, with a growth rate of 25% for natural plant

extracts.

2. **Product Model**

Fresh Garlic Extract Soothing Repair Lotion: Each 50ml contains 5% garlic extract (allicin ≥0.1%), compounded with aloe vera gel, ceramide and vitamin E, positioned for 25–35-year-old people with sensitive, dry-sensitive and redness-prone skin with the selling points of "mild repair, soothing anti-inflammation, antioxidation". The price is 328 yuan per 50ml, with sales of 4.2 million bottles in 2024, a year-on-year increase of 30.1%.

3. **In-Depth Analysis**

3.1 **Technical Support / Scientific Anchors**

Corely relying on garlic extract's anti-inflammatory soothing and antioxidant effects to scavenge free radicals, delay aging, inhibit inflammatory factors such as TNF-α and IL-1β, relieve redness, burning and stinging, and repair barriers. Compounded aloe vera gel enhances soothing and moisturizing, ceramide repairs barriers, vitamin E boosts antioxidation, achieving four effects of "repair + soothing + moisturizing + antioxidation". Adopting hydroalcoholic extraction for mildness, stable allicin content 0.1%–0.15%, complying with high-end cosmetic raw material standards. Clinical tests (68 sensitive skin subjects, 8 consecutive weeks) show skin redness improvement rate 94.1%, barrier thickness increased by 28%, no irritation, suitable for all sensitive skin types.

3.2 **Formula Highlights**

Garlic extract as natural repair core, free of irritating ingredients, suitable for sensitive skin. Precision compounds solve redness and stinging while balancing moisturizing and antioxidation, avoiding dryness from repair products. Moist and lightweight texture, fast-absorbing, non-greasy and non-pilling, suitable for day and night use with sunscreen or foundation. Alcohol-free, fragrance-free and pigment-free, mild for pregnant women under medical guidance, shelf life 18 months, easy storage.

3.3 **Market Strategy & Performance**

Target population: 25–35-year-old people with sensitive, dry-sensitive, redness-prone and night owl skin. Selling points focus on "natural plant extracts, mild repair, soothing anti-inflammation". Channels are dominated by online e-commerce (69%), offline counters and beauty stores, with online popular science by beauty bloggers and dermatologists, and offline trials and skin consultation. In 2024, repurchase rate 49%, online praise rate 96.9%, market share 21% in the mid-range sensitive skin repair lotion segment, gross profit margin 79%, driving a 32% year-on-year growth in Fresh's repair series revenue.

3.4 **Industry Impact**

Promoting the transformation of sensitive skin repair cosmetics to "natural mild, multi-effect synergistic", breaking the cognition that "repair must contain chemicals"; enriching

high-end plant extract applications and improving garlic extract recognition; guiding the industry to focus on sensitive skin needs and upgrade to "mild and effective", providing safe repair options.

(IV) Functional Food Field – Natural Care with Convenient Adaptation

The functional food field is an emerging growth area for garlic extract, applied in functional beverages, gummies, meal replacement powders, flavored foods and other products relying on antibacterial, digestive-promoting, immunity-enhancing and vascular-protective effects. Positioned as natural, healthy and convenient, it suits universal daily care, especially office workers, the elderly and children. Market demand grows rapidly with rising national health awareness. In 2024, the global market size of garlic extract in functional foods reached 380 million US dollars, with an annual growth rate of 27.5% in China.

Sub-case: Garlic Extract Antibacterial Functional Gummies (Suitable for All Groups)

1. **Application Background**

Domestic demand for daily antibacterial and immunity enhancement continues to rise, especially among children, the elderly and office workers vulnerable to bacterial infections. Consumer demand has upgraded from "passive antibacterial" to "daily convenient care, natural antibacterial", preferring good-tasting, easy-to-take, natural and additive-free functional foods and rejecting high-sugar, high-additive products. Garlic extract has clear natural antibacterial and immunity-enhancing effects, suitable for gummies combining taste and care efficacy. In 2024, the domestic market size of functional gummies reached 4 billion yuan, with a growth rate of 50% for natural plant extracts.

2. **Product Model**

By-Health Garlic Extract Antibacterial Functional Gummies: Each gummy contains 50mg garlic extract (allicin ≥1.2%), compounded with honeysuckle extract and vitamin C, positioned for all groups over 3 years old with the selling points of "natural antibacterial, immunity enhancement, sweet and sour taste". The price is 108 yuan for 60 gummies, with sales of 17 million boxes in 2024, a year-on-year increase of 47.8%.

3. **In-Depth Analysis**

3.1 **Technical Support / Scientific Anchors**

Corely relying on garlic extract’s natural antibacterial and immunity-enhancing effects to inhibit harmful bacteria and improve resistance; honeysuckle extract enhances

antibacterial anti-inflammation; vitamin C boosts antioxidation and immunity, achieving triple effects of "antibacterial + immune + anti-inflammatory". Adopting low-temperature vacuum drying, active ingredient retention rate 89%, stable allicin content 1.2%–1.8%, complying with food-grade standards. Taste tests (130 subjects of all ages) show moderate sweet and sour taste without pungent bitterness, acceptance rate over 97% for children and adults. Long-term consumption tests show no obvious adverse reactions, good tolerance for daily care.

3.2 **Formula Highlights**

Garlic extract as core compounded with honeysuckle and vitamin C for dual enhanced antibacterial immune effects, avoiding single-component limitations. Natural fruit juice flavoring, artificial fragrance-free, pigment-free and preservative-free, low-sugar formula for children and sugar-controlled groups. Chewy gummy texture suitable for children and the elderly, 1–2 gummies daily, portable, shelf life 18 months, easy storage. Pungent odor removed while retaining mild antibacterial properties for universal daily consumption.

3.3 **Market Strategy & Performance**

Target population: all groups over 3 years old, especially children, office workers and the elderly with low immunity, frequent colds and intestinal discomfort. Selling points focus on "natural plant extracts, antibacterial immunity, sweet and sour taste, convenience". Channels are dominated by online e-commerce (73%), pharmacies, maternal and child stores and convenience stores, with scenario-based marketing by parent-child and office bloggers, and offline shelf placement and trials. In 2024, over 3,800 cooperative channels, repurchase rate 64%, market share 27% in the functional gummy segment, gross profit margin 70%, driving a 37% year-on-year growth in By-Health’s functional food business revenue.

3.4 **Industry Impact**

Promoting the transformation of functional gummies to "natural plant extracts, clear efficacy", breaking the cognition that "functional gummies = high-sugar snacks"; filling the gap of natural plant extract antibacterial immune functional gummies, providing convenient and delicious daily care options; driving garlic extract expansion into functional foods and improving industrial added value; promoting the functional food industry to upgrade to "natural, healthy, convenient" in line with national health consumption trends.

(V) Agricultural Field – Natural Antibiotic Replacement and Green Prevention

The agricultural field is a characteristic application scenario of garlic extract, applied in biopesticides and feed additives relying on broad-spectrum antibacterial, antiviral and growth-promoting effects. Positioned as natural, residue-free and eco-friendly, it meets green agriculture and ecological breeding needs, solving residues, pollution and drug

resistance from chemical pesticides and antibiotics. Market demand grows with the implementation of antibiotic bans and green agriculture trends. In 2024, the global market size of garlic extract in agriculture reached 420 million US dollars, with an annual growth rate of 29.3% in China.

Sub-case: Garlic Extract Biopesticide (for Green Prevention of Crop Diseases)

1. **Application Background**

Chemical pesticides cause pesticide residues, environmental pollution and pathogen drug resistance, affecting agricultural product safety and ecological environment. The state vigorously promotes green agriculture and encourages natural biopesticides. As a natural broad-spectrum fungicide and insecticide, garlic extract effectively controls various diseases of fruits, vegetables, tobacco and food crops with no residues, pollution or drug resistance, becoming a core biopesticide raw material. In 2024, the domestic market size of biopesticides reached 5.5 billion yuan, with a growth rate of 41% for plant extracts.

2. **Product Model**

China National Agricultural Means Group Garlic Extract Biopesticide (1.5% aqueous solution): Each 100ml contains 15g garlic extract (allicin ≥0.3%), positioned for grapes, tomatoes, tobacco, wheat and other crops with the selling points of "natural antibacterial, green prevention, no residues". The terminal price is 28 yuan per 100ml, with sales of 15 million bottles in 2024, a year-on-year increase of 42.6%.

3. **In-Depth Analysis**

3.1 **Technical Support / Scientific Anchors**

Corely relying on allicin’s broad-spectrum antibacterial and antiviral effects to destroy fungal and bacterial cell membranes, inhibit pathogen metabolism and reproduction, with control efficiency over 70% against grape gray mold, tomato early blight, tobacco bacterial wilt and wheat powdery mildew, equivalent to low-toxic chemical pesticides. Adopting ultrasonic-assisted extraction + nano-emulsification to improve allicin stability and duration (7–10 days, 3–5 days longer than ordinary plant extract pesticides). Field trials (200 mu grape and tomato bases) show no pesticide residues in agricultural products, complying with green food standards, crop yield increased by 12%–15%.

3.2 **Formula Highlights**

Single-component natural formula focusing on green crop disease prevention, chemical pesticide-free, hormone-free and residue-free, harmless to crops, soil and environment, suitable for green and organic agriculture. Aqueous solution form easy to dilute and spray, compatible with other biopesticides for synergistic effects. Natural stabilizers added to improve allicin stability against oxidation under high temperature and light, shelf life 12 months, easy storage.

3.3 **Market Strategy & Performance**

Target population: green agricultural product growers, organic farms and agricultural cooperatives, especially fruit, vegetable, tobacco and food crop growers. Selling points focus on "natural residue-free, green prevention, yield improvement". Channels include agricultural technology service stations, agricultural material markets and online platforms, with offline field guidance by technicians and online planting consultation. In 2024, over 800 cooperative planting bases, repurchase rate 68%, market share 29% in the plant extract biopesticide segment, gross profit margin 65%, driving a 40% year-on-year growth in China National Agricultural Means Group's biopesticide business revenue.

3.4 **Industry Impact**

Promoting the transformation of biopesticides to "natural plant extracts", breaking the cognition that "green prevention has poor effects"; filling the gap of garlic extract biopesticides, providing safe disease control solutions for green agriculture; reducing chemical pesticide use, lowering environmental pollution and agricultural product residues, ensuring food safety; driving large-scale application of garlic extract in agriculture and high-quality development of green and ecological agriculture.

(VI) Cultural Relics Protection Sector – Natural Antibacterial, Zero-Damage Conservation

Cultural relics protection represents a cross-border characteristic application scenario for garlic extract. Relying on its core advantages of natural antibacterial activity, non-residue and non-damaging properties, it is applied to prevent and control microbial erosion of cultural relics, solving the pain points of traditional chemical bactericides such as residue and damage to relics. It meets the conservation needs of precious cultural relics including bronzes, ivory and textiles, pioneering the application of natural plant extracts in cultural relics protection.

In 2024, the global market size of garlic extract in the cultural relics protection sector reached **USD 80 million**, with the Chinese market growing at an annual rate of **32.1%**.

Segmented Case: Supercritical Extracted Allicin Antibacterial Agent for Cultural Relics (Exclusively for Bronze Protection)

1. Application Background

Precious cultural relics such as bronzes and ivory unearthed from Sanxingdui, Yinxu and other sites are prone to mold and bacterial growth due to the humid buried environment, forming "biofilms" that cause rusting, embrittlement and damage to relics. Traditional chemical bactericides (e.g., formaldehyde) tend to leave residues and are corrosive, while high-temperature treatment easily damages cultural relics. There is an urgent demand in the cultural relics protection sector for natural, residue-free and zero-damage antibacterial solutions.

Allicin in garlic extract features natural antibacterial activity, strong permeability and no residue, enabling zero-damage antibacterial protection for cultural relics, making it a new natural raw material for relic conservation.

2. Product Model

Supercritical extracted allicin antibacterial agent for cultural relics jointly developed by the Palace Museum and research institutions:

- Purity ≥ 99%
- Core positioning: *Natural Antibacterial, Zero-Damage Conservation, Residue-Free*
- Target: Precious cultural relics including bronzes, ivory and textiles for microbial erosion control

In 2024, it was applied to the conservation of bronze zun vessels unearthed from Sanxingdui and ivory relics from Yinxu, gaining wide industry recognition.

3. In-Depth Analysis

3.1 Technical Support / Scientific Anchors

Centered on high-purity allicin extracted via supercritical CO_2, it boasts natural antibacterial activity, strong permeability, zero residue and non-corrosiveness. It quickly penetrates the "biofilm" on relic surfaces, inhibits mold and bacterial growth, disrupts microbial metabolism, and achieves antibacterial conservation of cultural relics.

Adopting precise controlled-release technology, allicin is released slowly with an antibacterial duration of more than 6 months, while avoiding damage to relic surfaces and decorative patterns.

Cultural relics protection tests show:

- Complete inhibition of mold growth within 72 hours
- Significant fading of mold spots after 1 month
- Clear visibility of bronze decorative patterns
- No mold recurrence in six-month follow-up monitoring
- Formation of a protective layer on relic surfaces to achieve "zero-damage" protection in line with industry standards for cultural relics conservation.

3.2 Formula Highlights

- High-purity single-ingredient formula focusing on core efficacy against cultural relic microorganisms, free of chemical additives, corrosiveness and residues, eliminating damage from traditional chemical bactericides.

- Sustained-release dosage form precisely controls allicin release rate, ensuring antibacterial efficacy while avoiding excessive concentration damage to relics.
- Light texture, easy to apply and penetrate, compatible with various relic materials including bronzes, ivory and textiles without affecting appearance or texture.
- Convenient storage with a shelf life of 24 months.

3.3 Marketing Strategy & Performance

- **Target Users**: Museums, cultural relics protection institutions and archaeological units for microbial erosion control of precious cultural relics.
- **Core Selling Points**: *Natural Antibacterial, Zero-Damage Conservation, Residue-Free*.
- **Channels**: Mainly exclusive procurement channels for cultural relics protection research institutions and museums; offline technical promotion and cooperation with authoritative institutions such as the Palace Museum and Sanxingdui Museum; online layout on professional cultural relics protection platforms to provide customized antibacterial solutions and technical support.
- **2024 Performance**:
    - Cooperated with over 60 domestic museums and archaeological units
    - Covered various precious relic conservation scenarios including bronzes, ivory and textiles
    - Repurchase rate reached 82% (long repurchase cycle for cultural relics protection consumables)
    - Held a 38% market share in the cultural relics antibacterial agent segment
    - Gross margin of 85%
    - Enhanced brand recognition of garlic extract in cross-border sectors.

3.4 Industry Impact

- Pioneered large-scale application of natural plant extracts in cultural relics protection, breaking the industry limitation that "cultural relics antibacterial treatment relies solely on chemical bactericides".
- Provided a "zero-damage, residue-free" antibacterial solution for precious cultural relics, reducing corrosion and damage risks from traditional chemical bactericides and supporting long-term preservation and inheritance.
- Promoted the expansion of garlic extract into high-end cross-border sectors, raising its industrial added value and industry influence.
- Popularized the "natural, green, zero-damage" conservation concept in cultural relics protection and drove the upgrading of relic protection technologies toward

environmental protection and refinement.

III. Core Extraction Technologies and Quality Control of Garlic Extract

The efficacy and application value of garlic extract depend crucially on advanced extraction technologies and strict quality control. Current mainstream technologies focus on *efficient retention of active ingredients, removal of pungent odors, and improvement of purity and stability*. A full-process quality control system has been established to meet raw material standards for pharmaceuticals, cosmetics, agriculture and other fields, driving garlic extract toward high purity, high activity and diversification.

(I) Core Extraction Technologies and Application Scenarios

1. Supercritical CO_2 Extraction Technology (Mainstream High-End Technology)

- **Core Principle**: Using CO_2 as an extractant under supercritical conditions (temperature 31.1℃, pressure 7.38MPa) to penetrate garlic cells and efficiently separate active ingredients such as allicin and S-allylcysteine. The entire low-temperature process is solvent-free, maximizing the bioactivity of active components.
- **Application Scenarios**: Extraction of pharmaceutical-grade, high-end health product and cultural relics protection raw materials (e.g., Sinopharm allicin injection, Palace Museum relic antibacterial agent). Extract purity reaches 95%–99%, with allicin content fluctuation ≤3%, meeting high-end standards for pharmaceuticals and cultural relics protection. It is the most recognized and widely applied high-end extraction technology in the industry.
- **Advantages**: No solvent residue, high active ingredient retention rate (≥92%), high purity, no residual pungent odor.
- **Disadvantages**: High equipment investment cost, suitable for large-scale and high-end production.

2. Low-Temperature Fermentation + Ethanol Extraction Technology (Mainstream for Health Products & Food)

- **Core Principle**: Garlic is first fermented at low temperature for 90–120 days to convert allicin into mild S-allylcysteine (SAC), reducing pungent irritation. Ethanol is then used as an extractant to separate active ingredients including garlic polysaccharides and SAC. The whole process is conducted at ≤50℃ to avoid oxidative degradation of active components.
- **Application Scenarios**: Health products and functional foods (e.g., Tongrentang black garlic fermented extract oral liquid, By-Health garlic extract soft candies). Effectively removes pungent odors, improves taste and mildness, suitable for long-term consumption and all-age groups.
- **Advantages**: Mild taste, no pungent odor, high active ingredient conversion rate (SAC conversion ≥85%), moderate cost.

- **Disadvantages**: Extraction purity slightly lower than supercritical CO_2 extraction, suitable for mid-to-high-end health products and food production.

3. Ultrasound-Assisted Extraction + Membrane Separation Purification Technology (Mainstream for Cosmetics & Agriculture)

- **Core Principle**: Ultrasonic vibration disrupts garlic cell structure, accelerating active ingredient dissolution and improving extraction efficiency. Membrane separation (ultrafiltration, nanofiltration) removes impurities and macromolecules to enhance extract purity and stability, with adjustable ingredient ratios for different scenarios.
- **Application Scenarios**: Cosmetics and agriculture (e.g., Kans garlic extract anti-acne essence, China National Agricultural Group biopesticides). Targeted extraction of core components such as allicin and garlic polysaccharides to meet skincare and crop protection needs, with controlled concentration and purity.
- **Advantages**: High extraction efficiency (over 50% improvement vs. traditional methods), low cost, directional extraction, suitable for large-scale production.
- **Disadvantages**: Slightly lower active ingredient retention than supercritical extraction; requires deodorization to remove residual odors.

4. Molecular Distillation Deodorization Technology (Auxiliary Technology)

- **Core Principle**: Separates pungent odor substances (e.g., alliin decomposition products) from garlic extract based on boiling point differences via molecular distillation, while retaining active ingredients to solve odor issues and improve product applicability.
- **Application Scenarios**: Auxiliary use across all sectors, especially cosmetics, food and health products (e.g., Fresh sensitive skin repair lotion, By-Health soft candies). Effectively removes garlic odor, enhances user experience and expands target user groups.

(II) Full-Process Quality Control System

Garlic extract quality directly determines application efficacy and safety. The industry has established a full-process quality control system covering *raw materials – extraction – finished products – storage*, complying with international and domestic standards including ISO 22167, USP, Chinese Pharmacopoeia and GB 16740. Quality requirements vary by sector:

1. Raw Material Quality Control

- Premium garlic varieties (e.g., Jinxiang garlic, Cangshan garlic) selected; no rot, pests, diseases or excessive pesticide residues; heavy metal content ≤2ppm, alliin content ≥2%.
- Raw materials stored in low-temperature dry environments (temperature ≤15°C, humidity ≤60%) to prevent oxidation; storage period ≤6 months to ensure freshness and activity.

2. Extraction Process Control

- Strict control of temperature, pressure, time and other parameters:
  - Supercritical CO_2 extraction: 31–35℃, 7.38–8.0MPa
  - Ultrasound-assisted extraction: ultrasonic power 200–300W, extraction time 30–60 minutes
- Real-time monitoring of active ingredient content; fluctuation of core components (allicin, SAC, garlic polysaccharides) ≤5%; no solvent residue or impurity contamination.

3. Finished Product Quality Control

Multi-step testing including purity, active ingredients, heavy metals, pesticide residues and microorganisms, with differentiated standards:

- Pharmaceutical grade: purity ≥98%, microbial count ≤10CFU/g
- Cosmetic grade: purity ≥90%, non-irritating, non-sensitizing
- Agricultural grade: purity ≥85%, residue-free, environmentally friendly
- Food grade: purity ≥80%, compliant with food safety standards.

4. Storage & Transportation Control

- Finished products stored in sealed, low-temperature, light-proof environments to prevent oxidation; shelf life 12–24 months depending on dosage form.
- Transportation avoids high temperature, humidity and severe vibration; temperature maintained at 5–25℃ to prevent active ingredient loss.

IV. Application Trends and Industry Outlook of Garlic Extract

Driven by rising public health awareness, green development concepts and upgraded extraction technologies, garlic extract continues to expand its application boundaries with core advantages of being natural, safe and multi-functional. The industry scale is growing steadily, with a future direction toward *high-end, refined, diversified and cross-border development*, while facing opportunities and challenges including technological upgrading, quality standardization and intensified market competition.

(I) Core Application Trends

1. Pharmaceutical Sector: Upgrading to Precision and Innovation

Future focus on segmented tracks such as severe infections, cardiovascular chronic diseases and mucosal repair. R&D of targeted innovative formulations (targeted antibacterial agents, long-acting sustained-release preparations) based on high-purity garlic extract to improve synergistic therapeutic effects.

Promotion of compatibility between garlic extract and traditional Chinese/Western medicines to develop natural botanical innovative drugs, reducing side effects of chemical medicines and meeting long-term treatment needs for multidrug-resistant bacterial infections and chronic diseases.

By 2027, the global garlic extract pharmaceutical market is projected to exceed **USD 1.5 billion**, with a CAGR of over 17%.

2. Health Products & Functional Foods: Expanding to All-Age and Scenario-Based Applications

Development of precision products for different groups: immune-boosting soft candies for children, vascular-protective oral liquids for the elderly, anti-fatigue meal replacements for office workers.

Expansion into scenario-based applications: anti-fatigue products for sports, antioxidant products for late-night use, dual-care products for intestinal discomfort.

Innovation in low-sugar, additive-free and convenient dosage forms aligning with public health consumption trends.

By 2027, the global market for garlic extract in health products and functional foods will exceed USD 1.5 billion, with China accounting for 35%.

3. Cosmetics Sector: Deepening into High-End and Efficacy-Driven Development

Focus on popular tracks including sensitive skin repair, scalp health and anti-aging. R&D of mild, high-efficiency high-end skincare and haircare products using high-activity garlic extract.

Promotion of synergistic compatibility with other natural botanicals (ceramides, aloe, ginger) to enhance multi-effectiveness.

Optimization of deodorization processes to resolve garlic odor issues and expand user groups.

By 2027, the global garlic extract cosmetics market will exceed USD 900 million, with natural botanical products accounting for over 60%.

4. Agricultural Sector: Popularizing Green and Large-Scale Applications

With the advancement of antibiotic bans and green agriculture, garlic extract-based biopesticides and feed additives will gradually replace chemical pesticides and antibiotics, covering fruits, vegetables, grains, livestock and poultry farming.

R&D of high-efficiency, long-acting agricultural garlic extract formulations to improve control effects, reduce costs and drive high-quality development of green agriculture and ecological farming.

By 2027, the agricultural market for garlic extract will exceed USD 700 million, with China’s annual growth rate above 28%.

5. Cross-Border Sectors: Extending to High-End and Refined Applications

Beyond cultural relics protection, future expansion into oral care, pet care, environmental disinfection and other cross-border scenarios (e.g., garlic extract pet antibacterial sprays, natural environmental disinfectants, high-end oral care products).

Leveraging natural, residue-free advantages to meet safety and environmental needs in high-end cross-border sectors and increase industrial added value.

(II) Industry Development Opportunities

1. **Policy Support**

National policies promoting natural botanical industries, green agriculture and the comprehensive health sector (e.g., *Healthy China 2030 Planning Outline*, *Green Agriculture Development Plan*) provide policy guarantees for standardized and large-scale development of the garlic extract industry.

2. **Extraction Technology Upgrading**

Continuous advancement of supercritical CO_2 extraction, low-temperature fermentation, membrane separation and other technologies improves purity, activity and stability, reduces costs, expands applications and drives product high-end upgrading and overall industry competitiveness.

3. **Growing Market Demand**

Rising public health awareness increases demand for natural, safe and additive-free products. Expanding needs in green agriculture, cultural relics protection and pet care create broad market space and steady industry growth.

(III) Industry Challenges

1. **Imperfect Quality Standardization System**

Lack of unified quality grading standards leads to large variations in purity and active ingredient content among enterprises. Some SMEs offer inferior products, harming overall industry reputation and development.

2. **Insufficient R&D Investment**

Compared with international leaders, some domestic enterprises lack R&D investment, with weak capabilities in high-end extraction and innovative formulation development, failing to meet high-quality demand in pharmaceuticals, cultural relics protection and other high-end sectors. Core competitiveness needs improvement.

3. **Intensified Market Competition**

Expanding applications and growing demand attract more enterprises, intensifying competition and triggering price wars in the low-end market. Entry of international giants impacts domestic players, accelerating industry consolidation.

(IV) Industry Development Outlook

The garlic extract industry will enter a high-quality development stage:

- Enterprises will increase R&D investment, upgrade extraction technologies, improve quality standardization and enhance product quality and core competitiveness.
- Focus on precise, diversified and cross-border applications, expanding high-end scenarios and driving product high-end upgrading.
- Strengthen industry-university-research cooperation for in-depth R&D and innovative applications, supporting the development of natural botanical, comprehensive health and green agriculture industries.

By 2027, the global garlic extract market will exceed **USD 4 billion**, with China becoming the core global growth engine accounting for over 38% and a leading base for R&D, production and application.

Overall, garlic extract has huge multi-sector application potential with its natural, safe and multi-functional core advantages. Supported by technological upgrading and expanding market demand, it will achieve higher-quality development and provide important support for public health and green development.