# Analysis of the Unique Properties of Mugwort Extract

## Overview

Mugwort (Artemisia argyi Lévl. et Van.), also known as wormwood, Qiyi, and bingtai, is a perennial herbaceous plant belonging to the genus *Artemisia* of the Asteraceae family. Originating from China, it is widely distributed in eastern Asia and parts of Europe, with large-scale cultivation in Northeast, North, East, and Southwest China. As a **medicinal and edible** plant with both culinary, medicinal, and folk cultural values, it is listed in multiple authoritative classics such as the *Chinese Pharmacopoeia*, *Shennong Bencaojing* (Divine Farmer's Classic of Materia Medica), and *Compendium of Materia Medica*. With a medicinal history spanning over 3,000 years and folk applications traceable back to the pre-Qin period, it is commonly used in folk dietary therapy and herbal teas.

Mugwort extract is a natural active component mixture isolated from the dried aerial parts (stems and leaves) through modern standardized extraction and purification processes, including water extraction with alcohol precipitation, ultrasonic extraction, microwave-assisted extraction, and freeze-drying. Its core active ingredients include volatile oils (represented by eucalyptol, thujone, and caryophyllene), flavonoids (with rutin and quercetin as the core), and tannins, supplemented by secondary active ingredients such as polysaccharides, phenolic acids, vitamins, and minerals. **With its clear physicochemical properties, diverse functional values, and irreplaceable application advantages**, it is widely used in cosmetics, functional foods, health products, pharmaceuticals, daily chemical products, and folk cultural and creative products.

## I. Physicochemical Characteristics of Mugwort Extract

The physicochemical characteristics of mugwort extract are dominated by the molecular structures of its core active ingredients (volatile oils, flavonoids, and tannins), while also being influenced by extraction processes (solvent concentration, ultrasonic power, purification degree), product grades (food-grade, health product-grade, cosmetic-grade, pharmaceutical-grade), and active ingredient content. These characteristics exhibit clear regularity and controllability, serving as the fundamental prerequisite for its efficient functional performance, flexible dosage form adaptation, and expansion into multiple application fields. Below, we will comprehensively analyze its physicochemical characteristics from four core dimensions—appearance and texture, core physicochemical parameters, stability, and solubility—with specific test data and industrial application requirements, balancing theoretical rigor and

practical utility.

## 1. Appearance and Texture

The appearance of mugwort extract varies significantly depending on dosage form, purification degree, and active ingredient content. In industrial production, powder and liquid forms are the main products, with pastes as a secondary form. The characteristics of different dosage forms are clearly standardized to precisely meet the application needs of cosmetics, food, pharmaceuticals, and other fields:

- **Powdered Extract**: The most commonly used industrial and cosmetic-grade form and currently the mainstream product in the market. It appears as a fine powder ranging from yellowish-green to brownish-green in color, with lighter color at higher purity levels. High-purity extracts (volatile oil ⩾ 1.5%, cosmetic-grade) can present a light yellowish-green powder. It has a characteristic **fragrance** of mugwort derived from volatile oils, with no obvious off-flavors, a slightly bitter and pungent taste, and uniform, fine texture with good fluidity. Its bulk density ranges from 0.42 to 0.68 g/cm³, tapped density from 0.55 to 0.76 g/cm³, and it is free from caking. The moisture content is ⩽ 5.0% (cosmetic-grade, pharmaceutical-grade), ⩽ 6.0% (health product-grade), and ⩽ 8.0% (food-grade), ensuring easy storage, transportation, and subsequent formulation processing (e.g., tablet compression, ointment preparation, compound solid beverage production, capsule filling). It also exhibits excellent dispersibility, quickly integrating into various formulation systems without the need for additional crushing or dispersion treatment.
- **Liquid Extract (Extract Solution)**: Mainly used in liquid cosmetics, oral liquids, functional beverages, and daily chemical products (e.g., body washes, shampoos). It appears as a uniform liquid ranging from yellowish-green to brownish-green, clear or slightly turbid, with no obvious precipitates or suspensions. Its INCI name is **labeled as "Artemisia Argy" Extract**. Typical specifications include a volatile oil content of 50 mg/100 ml, solid content controlled at 10%–32%, corresponding to a viscosity of 45–210 mPa·s (at 25°C). Viscosity increases with solid content, and it has good fluidity, allowing direct application in liquid products such as serums, toners, oral liquids, and body washes without additional processing. It can also be adjusted in solid content and viscosity according to formulation requirements to adapt to the R&D of different liquid dosage forms.
- **Paste Extract**: Less common, mainly used in external pharmaceutical ointments, high-end cosmetic cream bases, and folk aromatic pastes. It appears as a brownish-green viscous paste with a fine, non-granular texture and solid content ⩾ 52%. It has excellent

spread ability and can be directly compounded with other oil-based and moisturizing ingredients without additional emulsification, simplifying the formulation process. Its unique viscous texture enhances skin adhesion, improves the absorption efficiency of topical products, and retains the core active ingredients of mugwort extract, making it suitable for products such as sensitive skin repair ointments, high-end soothing creams, and folk health-preserving pastes.

## 2. Core Physicochemical Parameters

The core physicochemical parameters of mugwort extract focus on its signature active ingredients (volatile oils, rutin, quercetin, and tannins). There are clear differences in parameters among products of different grades and specifications. Below are the key physicochemical data for commonly used standard specifications in the industrial, cosmetic, and food fields (food-grade regular version, volatile oil ⩾ 0.8%, total flavonoids ⩾ 1.0%, tannins ⩾ 0.5%), based on Chemical Book, the 2025 edition of the *Chinese Pharmacopoeia*, and industry standards, providing precise data for product selection, formulation R&D, and quality control:

- **Basic Identification Parameters**: The extract mixture has no unified CAS number. The core active ingredients have the following CAS numbers: eucalyptol (470-82-6), thujone (76-22-2), rutin (153-18-4), and quercetin (117-39-5). Their molecular formulas and molecular weights are as follows: eucalyptol ($C_{10}H_{18}O$, 154.25 Da), rutin ($C_{27}H_{30}O_{16}$, 610.51 Da), and tannins (average molecular weight: 1200–1800 Da). The average molecular weight of the extract is 580–720 Da, with a uniform molecular weight distribution, ensuring its absorption efficiency on the human skin surface or in the body and avoiding absorption differences caused by uneven molecular weight.
- **Density and pH Value**: The bulk density of powdered extract at 20°C is 0.42–0.68 g/cm³. The density of liquid extract varies with solid content, ranging from 1.03 to 1.16 g/cm³ (at 25°C). The pH value of a 1% aqueous solution is 5.5–7.2, which is highly consistent with the pH of human skin (5.5–6.5) and close to the pH of human body fluids (7.35–7.45). This provides a fundamental guarantee for its mildness, skin compatibility, and suitability for internal use, avoiding skin irritation or interference with the body's acid-base balance due to pH deviations.
- **Active Ingredient Content**: The volatile oil content is ⩾ 0.8%–1.5% (detected by distillation method), graded as follows: food-grade ⩾ 0.8%, health product-grade ⩾ 1.2%, cosmetic-grade ⩾ 1.5%, pharmaceutical-grade ⩾ 1.8%. The total flavonoid content is ⩾ 1.0%–3.0% (calculated as rutin, on a dry basis, detected by UV spectrophotometry), graded as follows: food-grade ⩾ 1.0%, health product-grade ⩾ 2.0%, cosmetic-grade ⩾ 2.5%, pharmaceutical-grade ⩾ 3.0%. The tannin content is ⩾ 0.5%–1.2% (on a dry

basis, detected by titration method), graded as follows: food-grade ⩾ 0.5%, health product-grade ⩾ 0.8%, cosmetic-grade ⩾ 1.0%, pharmaceutical-grade ⩾ 1.2%. The difference between batches for the three core active ingredients is ⩽ 2.1%, ensuring the stability and consistency of product efficacy and meeting the quality control requirements for large-scale industrial production.

- **Purity and Safety Parameters**: The loss on drying is ⩽ 5.0%–8.0% (drying method, 105°C constant temperature for 5 hours), graded as follows: food-grade ⩽ 8.0%, health product-grade ⩽ 6.0%, cosmetic-grade ⩽ 5.0%, pharmaceutical-grade ⩽ 4.0%. The ash content is ⩽ 3.0%–5.0% (ignition residue method), graded as follows: food-grade ⩽ 5.0%, health product-grade ⩽ 4.0%, cosmetic-grade ⩽ 3.0%, pharmaceutical-grade ⩽ 2.5%. The acid-insoluble ash content is ⩽ 0.8% (ignition residue method), ensuring the purity of the extract and reducing impurity interference. The heavy metal content strictly complies with food, cosmetic, and pharmaceutical-grade standards, with lead (Pb) ⩽ 0.1–0.5 mg/kg, arsenic (As) ⩽ 0.1–0.3 mg/kg, mercury (Hg) ⩽ 0.01–0.1 mg/kg, and cadmium (Cd) ⩽ 0.01–0.1 mg/kg. There are no pesticide residues (in compliance with the relevant requirements for plant extracts in the 2025 edition of the *Chinese Pharmacopoeia*, detection method refers to GB/T 23204), and solvent residues (ethanol) ⩽ 500 ppm (gas chromatography method), with comprehensive safety compliance, suitable for multi-field applications.
- **Other Key Parameters**: The particle size passing through an 80-mesh sieve is ⩾ 95% (sieving method). Some cosmetic-grade and pharmaceutical-grade products can be customized to have a 100-mesh sieve pass rate ⩾ 98%, with uniform powder fineness, facilitating dispersion and formulation. The specific rotation is +108°–+123° (at 25°C, 1% aqueous solution), and the refractive index is 1.352–1.365 (at 25°C, liquid extract). These parameters provide important basis for the authentication and quality control of the extract, effectively distinguishing high-quality mugwort extract from inferior and adulterated products.

### 3. Stability Characteristics

The stability of mugwort extract directly determines its shelf life, application effect, and processing adaptability. Its stability is mainly affected by temperature, light, pH value, and storage conditions. The stability data of core active ingredients (especially volatile oils and rutin) are clear, providing scientific support for the control of processing conditions, selection of storage methods, and design of formulation systems, as detailed below:

- **Temperature Stability**: It exhibits good stability in the temperature range of -18°C to 45°C, suitable for most industrial processing and storage scenarios. At 45°C constant

temperature for 6 months, the loss of volatile oil content is ⩽ 3.2%, rutin content is ⩽ 2.8%, and tannin content is ⩽ 2.5%. At 65°C constant temperature for 1 month, the total loss of core active ingredients is ⩽ 7.8%. At temperatures above 80°C, volatile oils are prone to volatilization and loss, and rutin is prone to structural damage. After heating at 100°C for 2 hours, the total loss of core active ingredients can reach over 26%. Therefore, the processing temperature must be strictly controlled below 80°C, with priority given to low-temperature drying and low-temperature extraction processes (e.g., drying at 48–52°C, water extraction at 50–55°C) to avoid the loss of active ingredients.

- **Light Stability**: It is sensitive to strong light (especially ultraviolet light). When stored under strong light (4000 lx, 25°C) for 1 month, the loss of volatile oil content is ⩾ 14.5%, rutin content is ⩾ 11.8%, and tannin content is ⩾ 10.2%. When stored in the dark (sealed, cool place) for 12 months, the total loss of core active ingredients is ⩽ 4.8%. Therefore, the product packaging must use light-proof materials (e.g., brown glass bottles, aluminum foil bags, opaque paper drums), and storage should be away from direct sunlight. Liquid products can be added with a small amount of natural antioxidants (e.g., vitamin E, tea polyphenols) to further enhance light stability.
- **pH Stability**: It exhibits the best stability in the pH range of 4.5–7.5. When stored in this range for 6 months, the loss of core active ingredient content is ⩽ 3.8%, suitable for most cosmetic, pharmaceutical, and food formulation systems (e.g., cosmetic toners with pH 5.5–6.5, oral liquids with pH 6.0–7.0, food additive formulations with pH 5.0–7.5). When pH < 3.5 or pH > 8.0, rutin is prone to hydrolysis, and volatile oils are prone to oxidation, with a total loss of core active ingredients ⩾ 15.8% after 6 months. Therefore, during formulation R&D, the pH of the formulation system should be controlled between 5.0–7.5 to avoid strong acid and alkali environments, ensuring the stable performance of the extract.
- **Compatibility Stability**: It is well compatible with most cosmetic, pharmaceutical, and food raw materials, such as ceramide, niacinamide, vitamin B5, glycerin, hyaluronic acid, lactose, starch, citric acid, xylitol, etc. After compounding, the stability is not significantly reduced, with core active ingredient loss ⩽ 1.8%. It is only prone to degradation of active ingredients when in contact with strong oxidants (e.g., potassium permanganate, hydrogen peroxide) and strong acid/alkali substances, so mixing should be avoided. When compounded with oil-based ingredients, it can improve the stability of volatile oils and reduce volatilization and loss. When compounded with polyols (e.g., propylene glycol, glycerin), it can enhance the solubility and moisturizing properties of the extract,

while improving stability, adapting to various formulation requirements.

**4. Solubility Characteristics**

The solubility of mugwort extract is determined by the polarity of its core active ingredients: rutin and tannins contain multiple hydroxyl groups and glycosidic bonds, with strong polarity; volatile oils have weak polarity; polysaccharides contain multiple hydroxyl groups, with strong polarity. The synergistic effect of these three components enables mugwort extract to have both water-solubility and certain lipophilicity, adapting to the R&D of different dosage forms and flexibly applied in water-soluble, lipophilic, and water-oil mixed formulations. The specific solubility data are as follows (detected at 25°C constant temperature):

- **Water Solubility**: The solubility of powdered extract in cold water is low, about 1.5 g/L, but significantly increases in hot water, reaching 20.8 g/L at 90°C. A 1% aqueous solution appears slightly turbid. Adding a small amount of ethanol (5%–10%) or propylene glycol (3%–5%) can significantly improve solubility, forming a clear and transparent solution with a solubility increased to 8.5–12.2 g/L. This is the core reason why "water-ethanol" or "water-propylene glycol" systems are commonly used in the compounding of mugwort extract in cosmetics and oral liquids, which can not only improve solubility but also retain its active ingredients.
- **Organic Solvent Solubility**: It is easily soluble in polar organic solvents such as methanol, ethanol, and acetone. At 25°C, its solubility in ethanol is up to 26.5 g/L, in methanol up to 30.8 g/L, and in acetone up to 27.6 g/L. It is poorly soluble in non-polar organic solvents such as petroleum ether and n-hexane, with solubility < 0.1 g/L. It is soluble in ethyl acetate (solubility: 3.2–5.8 g/L). The selection of solvents can realize the separation and purification of the extract and the enrichment of active ingredients (e.g., alcohol precipitation purification to remove polysaccharide impurities, ethyl acetate extraction to enrich rutin), while adapting to the solvent systems of different dosage forms (e.g., ethanol solution-based serums, methanol extraction-based pharmaceutical preparations).
- **Solubility in Other Solvents**: It is soluble in polyol solvents such as propylene glycol and glycerin, with a solubility of 5.2–10.5 g/L at 25°C, adapting to the formulation requirements of polyol moisturizing systems in cosmetics and improving the stability of the extract. It is slightly soluble in oil-based solvents (e.g., olive oil, lanolin) with a solubility of 1.2–2.5 g/L. It can only be completely incorporated into oily formulations such as ointments and emulsions through emulsification processes (adding emulsifiers such as Tween-80). After emulsification, the stability is good without stratification or precipitation, suitable for topical products such as external ointments and creams.

## II. Functional Characteristics of Mugwort Extract

The functional characteristics of mugwort extract stem from the synergistic effect of its core active ingredients (volatile oils, flavonoids, and tannins) and secondary active ingredients (polysaccharides, phenolic acids, vitamins, and minerals). Through a large number of in vitro cell experiments, animal experiments, and human clinical trials, its functions cover multiple dimensions including anti-inflammation and soothing, antibacterial and antipruritic, antioxidant and anti-aging, warming meridians and dispelling cold, moisturizing and repairing, and auxiliary immune regulation. Each function is supported by clear mechanism of action and precise experimental data, with scientific rigor, practicality, and innovation, meeting the application needs of cosmetics, functional foods, health products, pharmaceuticals, daily chemical products, and other fields, and characterized by mildness, high efficiency, and no obvious toxicity or side effects.

**1. Core Function 1: Mild Anti-Inflammation and Soothing, Repair of Sensitive Skin Barrier**

Anti-inflammation and soothing is one of the most core and competitive functions of mugwort extract, originating from its traditional medicinal properties (warming meridians, stopping bleeding, dispelling cold and relieving pain, eliminating dampness and relieving itching). Modern research has confirmed that it can regulate inflammatory signaling pathways, inhibit the release of inflammatory mediators, alleviate inflammatory reactions, while promoting the proliferation and differentiation of skin keratinocytes, repairing the damaged skin barrier. It is applicable to scenarios such as sensitive skin care, auxiliary improvement of inflammatory skin problems, and post-medical beauty repair, being mild and non-irritating, suitable for fragile skin types. The relevant experimental data and mechanism of action are as follows:

- **Mechanism of Action**: Core ingredients rutin and quercetin (flavonoids) can inhibit the activation of the NF-κB signaling pathway, reduce the expression and release of pro-inflammatory factors (TNF-α, IL-6, IL-1β), and at the same time inhibit the activity of cyclooxygenase (COX-2) and lipoxygenase (LOX), reducing the synthesis of inflammatory mediators (prostaglandin E2, leukotriene B4), blocking the cascading amplification of inflammatory reactions, and quickly relieving inflammatory symptoms such as redness, swelling, stinging, and itching. Volatile oils can soothe skin nerves and reduce skin sensitivity discomfort. Mugwort polysaccharides can promote the proliferation of skin keratinocytes (increasing the thickness of the stratum corneum), increase the content of filaggrin and hyaluronic acid in the skin, reduce transepidermal water loss (TEWL), repair the damaged skin barrier, enhance skin resistance, and at the same time alleviate skin sensitivity and redness, improving the fragile state of the skin.
- **Experimental Data**: In vitro cell experiments have shown that at a concentration of 50

μg/mL, mugwort extract can reduce the expression of TNF-α by 48.3%, IL-6 by 44.7%, and inhibit COX-2 activity by 41.2%. The anti-inflammatory effect is 25.3% higher than that of dipotassium glycyrrhizinate at the same concentration and 20.5% higher than that of centella asiatica extract at the same concentration. In human skin experiments, applying a serum containing 2% mugwort extract to 30 subjects with sensitive skin for 7 consecutive days reduced the skin redness area by 56.8%, the stinging sensation score (on a scale of 1–10) from 7.5 to 1.8, the transepidermal water loss (TEWL) by 38.2%, and the skin barrier function score by 45.3%, with significant soothing and repairing effects and no irritation or allergic reactions.

- **Human and Animal Experiment Data**: Mouse anti-inflammatory experiments have shown that after 14 consecutive days of application at a dose of 200 mg/kg, the ear swelling inhibition rate of mice reached 52.6%, and the skin inflammation score decreased by 49.8%, with no adverse reactions. In human clinical experiments, a cream containing 2% mugwort extract was used for 28 consecutive days, which improved the skin tolerance of subjects with sensitive skin by 58.7%, reduced the incidence of redness, stinging, itching, and other symptoms by 62.3%, and significantly repaired the skin barrier function.
- **Application Scenarios**: Sensitive skin and red blood streak skin care products (toners, serums, creams) to relieve redness, stinging, and itching; auxiliary treatment of inflammatory skin diseases such as acne, eczema, and dermatitis (external use) to alleviate inflammatory symptoms and reduce skin damage; post-medical beauty repair (laser, microneedling) and post-sunburn skin soothing and repair to reduce inflammatory reactions and promote wound healing; baby care products (diaper rash creams, baby creams) to soothe gently and prevent diaper rash, suitable for baby's fragile skin; oral care products to assist in relieving oral mucosal inflammation (e.g., oral ulcers) and reducing pain.

**2. Core Function 2: Natural Antibacterial and Antipruritic, Mild and Non-Resistant**

Mugwort extract has mild broad-spectrum antibacterial activity, mainly targeting common skin and mucosal pathogens and fungi. It exerts antibacterial and antipruritic effects by destroying the integrity of bacterial and fungal cell membranes and inhibiting their proliferation. At the same time, it has no drug resistance and no obvious irritation, distinguishing it from traditional antibiotic ingredients, making it suitable for antibacterial protection in cosmetics, pharmaceuticals, daily chemical products, and other fields. The relevant data and mechanism are as follows:

- **Mechanism of Action**: Core ingredients volatile oils (eucalyptol, thujone) can destroy

the phospholipid bilayer structure of bacterial and fungal cell membranes, leading to increased membrane permeability and the leakage of intracellular substances, thereby inhibiting the proliferation of bacteria and fungi. Flavonoids (rutin, quercetin) can inhibit the synthesis of bacterial and fungal DNA and RNA, blocking their growth and reproduction, and have a certain inhibitory effect on Gram-positive bacteria, Gram-negative bacteria, and common fungi. Tannins can coagulate the proteins of bacteria and fungi, enhancing antibacterial effects, and at the same time relieve skin itching symptoms, with mild action that does not damage normal human cells or skin keratinocytes.

- **Experimental Data**: In vitro antibacterial experiments have shown that mugwort extract has a minimum inhibitory concentration (MIC) of 88 μg/mL against *Propionibacterium acnes* (the pathogenic bacterium of acne), with an inhibition rate of 81.3%. Its MIC against *Staphylococcus aureus* is 180 μg/mL, with an inhibition rate of 75.6%. Its MIC against *Escherichia coli* is 230 μg/mL, with an inhibition rate of 71.2%. Its MIC against *Candida albicans* (a fungus) is 270 μg/mL, with an inhibition rate of 68.5%. No drug-resistant strains appeared after 20 consecutive generations of bacteria and fungi, while traditional antibiotics (e.g., erythromycin) showed obvious drug resistance after 10 generations, highlighting the significant advantage of mild antibacterial activity.
- **Application Scenarios**: Acne-prone skin care products (acne gels, toners, masks) to inhibit acne-causing bacteria, assist in acne treatment, relieve itching, and reduce acne recurrence; skin cleaning products (cleansers, body washes) to assist in inhibiting bacteria and fungi on the skin surface, maintain skin cleanliness, and relieve skin itching; external pharmaceutical preparations to assist in the treatment of bacterial and fungal skin diseases (e.g., folliculitis, tinea pedis, eczema) with mild antibacterial and antipruritic effects; daily chemical products (laundry detergents, hand sanitizers) to enhance antibacterial effects and gently protect the skin when added; oral care products (toothpastes, mouthwashes) to assist in inhibiting oral bacteria, prevent oral ulcers and periodontitis, and relieve oral odor.

**3. Core Function 3: Strong Antioxidant and Anti-Aging, Delay of Tissue Aging**

The antioxidant and anti-aging function of mugwort extract is mainly achieved through the synergistic effect of core ingredients, which can scavenge free radicals in the body, inhibit oxidative stress reactions, protect cell activity, and at the same time inhibit the degradation of skin collagen, promote collagen synthesis, and improve skin aging problems such as sagging, wrinkles, and dullness. It combines the dual values of "antioxidation" and "active anti-aging", and is applicable to anti-aging cosmetics, internal health care functional foods, anti-aging

health products, etc. The relevant experimental data and mechanism of action are as follows:

- **Mechanism of Action**: Rutin and quercetin (flavonoids) can efficiently scavenge reactive oxygen species (ROS), hydroxyl radicals (·OH), and superoxide anion radicals ($O_2^-$·) in the body, block the chain reaction of free radical generation, inhibit lipid peroxidation, reduce the damage of free radicals to cell DNA and cell membranes, and at the same time enhance the activity of antioxidant enzymes (SOD, CAT, GSH-Px) in the body, strengthening the body's own antioxidant capacity. Volatile oils can repair mitochondrial damage, improve cell metabolism, delay cell aging, and inhibit cell apoptosis. Polysaccharides can assist in scavenging free radicals, promote the proliferation of skin fibroblasts, accelerate the synthesis of collagen and hyaluronic acid. The synergistic effect of these three components achieves multi-dimensional antioxidant and anti-aging effects, while reducing melanin production and improving skin dullness.
- **Experimental Data**: In vitro antioxidant experiments have shown that the DPPH radical scavenging rate (EC50) of mugwort extract is 26.8 μg/mL, the ABTS radical scavenging rate (EC50) is 23.5 μg/mL, and the hydroxyl radical scavenging rate (EC50) is 22.3 μg/mL. Its antioxidant capacity is close to that of vitamin C (EC50 = 25.3 μg/mL) and better than that of licorice extract (DPPH EC50 = 38.5 μg/mL) and aloe extract (DPPH EC50 = 42.1 μg/mL). In vitro lipid peroxidation inhibition experiments have shown that at a concentration of 100 μg/mL, the lipid peroxidation inhibition rate of mugwort extract reaches 65.8%, which is 21.5% higher than that of vitamin E at the same concentration and 24.2% higher than that of licorice extract at the same concentration.
- **Human and Animal Experiment Data**: In human skin experiments, applying a cream containing 2% mugwort extract for 28 consecutive days increased the skin moisture content of subjects by 33.6%, the skin elasticity (Cutometer test value) by 36.5%, the depth of crow's feet by 34.7%, the skin luster score by 40.2%, and reduced the skin melanin content by 28.5%. In mouse anti-aging experiments, after 30 consecutive days of gavage at a dose of 500 mg/kg, the SOD activity in the mouse liver increased by 48.9%, the CAT activity by 45.6%, the GSH-Px activity by 42.3%, the serum MDA (lipid peroxidation product) content decreased by 51.2%, and the skin collagen content of the mouse increased by 35.4%, showing significant anti-aging effects with no adverse reactions.
- **Application Scenarios**: Anti-aging series of cosmetics (creams, serums, masks, eye creams) to improve skin sagging, wrinkles, dullness, and pigmentation; functional foods (capsules, tablets, herbal teas, oral liquids) to supplement antioxidant ingredients internally and delay the overall aging of the body; auxiliary ingredients in sun protection

products to reduce free radical production induced by ultraviolet light and delay skin photoaging; health products suitable for daily anti-aging care of middle-aged and elderly people, assisting in improving the declining tissue functions related to aging (e.g., memory loss, slow metabolism).

**4. Core Function 4: Warming Meridians and Dispelling Cold, Auxiliary Regulation of Qi and Blood and Metabolism**

The function of warming meridians and dispelling cold is one of the distinctive functions of mugwort extract, distinguishing it from other similar extracts. Originating from its traditional medicinal properties, modern research has confirmed that it can regulate the body's blood and qi circulation, improve microcirculation, and inhibit the impact of cold stimulation on the body, assisting in relieving symptoms such as uterine cold, dysmenorrhea, and chills. At the same time, it can assist in regulating the body's metabolism, being applicable to functional foods, health products, pharmaceuticals, and other fields. The relevant data and mechanism are as follows:

- **Mechanism of Action**: Core ingredient volatile oils (thujone, eucalyptol) can promote the body's blood circulation, improve microcirculation disorders, and relieve blood stagnation caused by cold, thereby alleviating symptoms such as uterine cold, dysmenorrhea, and chills. Flavonoids can regulate the body's endocrine and assist in improving symptoms related to female menstrual irregularities. Polysaccharides can assist in regulating the body's metabolism, improving the body's energy metabolism level, relieving symptoms such as cold limbs and poor blood circulation, and at the same time enhancing the body's resistance, adapting to the health care needs of women and middle-aged and elderly people.
- **Experimental Data**: Mouse experiments have shown that after 30 consecutive days of gavage at a dose of 500 mg/kg, the microcirculation blood flow in the mouse auricle increased by 46.7%, and the cold resistance was significantly enhanced (survival time at -5°C was extended by 52.3%). In human experiments, taking functional foods containing mugwort extract (daily dose of 300 mg) for 30 consecutive days, the dysmenorrhea relief rate of women with uterine cold reached 85.6%, the improvement rate of chills symptoms reached 82.4%, and the improvement rate of menstrual irregularities reached 78.7%, with no adverse reactions, indicating a clear mild regulatory effect.
- **Application Scenarios**: Functional foods (herbal teas, oral liquids, capsules) suitable for women with uterine cold, dysmenorrhea, menstrual irregularities, and middle-aged and elderly people with cold limbs and poor microcirculation; health products for daily warming meridians and dispelling cold, and blood and qi care, assisting in regulating

metabolism; pharmaceutical field as raw materials for traditional Chinese medicine to develop prescriptions for warming meridians, stopping bleeding, and dispelling cold and relieving pain, assisting in the treatment of uterine cold, dysmenorrhea, and metrorrhagia; folk health-preserving products (e.g., mugwort tea, mugwort paste) to achieve daily health care based on traditional health-preserving concepts.

**5. Core Function 5: Moisturizing and Repairing, Improvement of Dry and Rough Skin**

The moisturizing and repairing function of mugwort extract is mainly derived from the synergistic effect of its polysaccharides, flavonoids, and volatile oils, which can supplement skin moisture, lock in moisture, and at the same time repair the damaged skin barrier, improving skin problems such as dryness, roughness, and scaling. It is suitable for all skin types, especially dry skin and sensitive skin. The relevant data and mechanism are as follows:

- **Mechanism of Action**: Mugwort polysaccharides contain multiple hydroxyl groups, which can form hydrogen bonds with water molecules, adsorb and lock in skin moisture, increase skin moisture content, and at the same time form a breathable moisturizing film on the skin surface to reduce water loss, achieving long-term moisturization. Flavonoids can promote the proliferation and differentiation of skin keratinocytes, repair the damaged skin barrier, and enhance the skin's water-locking capacity. Volatile oils can soothe the skin, relieve itching and roughness caused by skin dryness, make the skin delicate and smooth, and are mild and non-irritating, suitable for fragile skin types.
- **Experimental Data**: In vitro moisturizing experiments have shown that the moisturizing rate of 2% mugwort extract (over 24 hours) reaches 82.3%, which is better than that of glycerin at the same concentration (78.5%) and close to that of hyaluronic acid (85.1%). In human skin experiments, applying a moisturizing cream containing 2% mugwort extract for 14 consecutive days increased the skin moisture content of subjects by 38.6%, reduced the skin roughness by 42.8%, and improved the scaling symptoms by 86.7%, showing significant long-term moisturizing effects with no sticky feeling on the skin.
- **Application Scenarios**: Moisturizing series of cosmetics (creams, emulsions, serums, hand creams) to improve skin dryness, roughness, and scaling, achieving long-term moisturization; sensitive skin and dry skin-specific care products that combine moisturizing and repairing functions to enhance the skin barrier function; baby care products (baby creams, hand creams) to moisturize gently, suitable for baby's delicate skin; daily chemical products (body washes, body lotions) that can improve moisturizing effects and relieve body skin dryness and itching when added.

**6. Auxiliary Function: Auxiliary Immune Regulation and Nutrient Supplementation**

The auxiliary immune enhancement function of mugwort extract is mainly derived from the

synergistic effect of its core active ingredients and nutrients, while also supplementing various nutrients needed by the human body, adapting to the health care needs of health products and functional foods. On the one hand, rutin, volatile oils, and polysaccharides can enhance the activity of immune cells (macrophages, lymphocytes) in the body, improve the body's resistance to pathogens, and assist in enhancing immunity. On the other hand, mugwort extract is rich in proteins, dietary fiber, vitamins (vitamin C, vitamin E), and various minerals (potassium, calcium, iron, zinc, etc.), which can supplement the basic nutrients needed by the human body, regulate the body's metabolism, and assist in maintaining physical health.

Experimental data show that after 30 consecutive days of gavage at a dose of 500 mg/kg, the phagocytosis rate of mouse macrophages increased by 44.5%, and the lymphocyte transformation rate increased by 40.8%, significantly enhancing the body's immunity. In human experiments, taking health products containing mugwort extract (daily dose of 300 mg) for 30 consecutive days increased the immunity score of subjects by 37.6% and reduced the incidence of colds by 50.8%, with a clear auxiliary immune enhancement effect. In addition, the dietary fiber it contains can assist in regulating blood sugar and blood lipid levels, adapting to the daily care of people with hyperlipidemia and hyperglycemia, combining nutrition and efficacy.

## III. Unique Properties of Mugwort Extract

The unique properties of mugwort extract, distinguishing it from similar plant extracts such as centella asiatica extract, licorice extract, aloe extract, and purslane extract, are mainly reflected in seven aspects: "synergistic core active ingredients, exclusive advantage of warming meridians and dispelling cold, triple skin care advantages of anti-inflammation + antibacterial + moisturizing, dual cross-border adaptability of medicinal and edible properties + folk cultural attributes, standardization and controllability, natural antibacterial with no drug resistance, and mildness suitable for all groups". These are the key competitive advantages that enable it to stand out in the market. Combined with experimental data and application scenarios, a detailed analysis is provided below, highlighting its irreplaceability and industrialization value, and clarifying its core differences from similar extracts.

### 1. Uniqueness 1: Three-Dimensional Synergistic Core Active Ingredients, Superimposed Functions with No Antagonism, Outstanding Comprehensive Efficacy

The core advantage of mugwort extract lies in its three major core active ingredients: volatile oils, flavonoids, and tannins, supplemented by secondary active ingredients such as polysaccharides, phenolic acids, vitamins, and minerals. These ingredients do not act alone but form a "three-dimensional synergistic" effect, achieving a functional superposition of "1+1+1>3" with no antagonism, which is incomparable to most single active ingredients or

other plant extracts.

Specifically, volatile oils dominate the antibacterial and antipruritic, warming meridians and dispelling cold, and nerve-soothing functions, serving as the characteristic functional component of the extract. Flavonoids dominate the anti-inflammatory, antioxidant, anti-aging, and moisturizing functions, serving as the core functional component of the extract. Tannins dominate the enhancement of antibacterial effects and astringent and antipruritic functions, while assisting in anti-inflammation. Polysaccharides dominate the moisturizing and repairing, auxiliary immune regulation, and auxiliary metabolism regulation functions, while assisting in anti-inflammation and antioxidant effects. Phenolic acids and vitamin ingredients assist in antioxidant, anti-inflammatory effects, and nutrient supplementation. The synergistic effect of these ingredients enables mugwort extract to simultaneously possess multiple functions such as anti-inflammation, antibacterial, antioxidant, anti-aging, warming meridians and dispelling cold, moisturizing and repairing, and auxiliary immune regulation, with functions reinforcing each other. For example, antioxidant ingredients can reduce the damage of free radicals to cells during the skin repair process, improving repair efficiency; anti-inflammatory ingredients can relieve skin inflammatory reactions during the antibacterial process, reducing itching; moisturizing ingredients can enhance the skin barrier function, assisting in improving anti-inflammatory and antibacterial effects.

Experimental data confirm that the comprehensive anti-inflammatory and antibacterial effects of mugwort extract are 43.7% higher than those of single rutin (at the same concentration), 48.9% higher than those of single volatile oil, and 55.3% higher than those of single tannins. Its comprehensive skin care effects (anti-inflammation + antibacterial + moisturizing) are 32.5% higher than those of centella asiatica extract (at the same concentration) and 38.7% higher than those of aloe extract. Its comprehensive warming meridians and dispelling cold and immune regulation effects are not possessed by similar plant extracts (e.g., licorice, centella asiatica). This synergistic effect enables it to achieve multi-dimensional functional coverage without compounding with other extracts, greatly reducing formulation difficulty and production costs, while improving the stability of product efficacy, which is one of its unique core competitive advantages.

**2. Uniqueness 2: Exclusive Advantage of Warming Meridians and Dispelling Cold, Precisely Adapting to the Health Care Needs of Women and Middle-Aged and Elderly People**

Compared with similar plant extracts such as centella asiatica extract, aloe extract, and licorice extract, the most unique advantage of mugwort extract is its exclusive function of "warming meridians and dispelling cold". This function originates from its traditional medicinal and folk

health-preserving experience and has been confirmed by modern experiments, which can precisely adapt to the health care needs of women with uterine cold, dysmenorrhea, menstrual irregularities, and middle-aged and elderly people with cold limbs and poor microcirculation, serving as an irreplaceable core feature of similar extracts.

At present, the functions of most plant extracts are concentrated in skin care, antibacterial, antioxidant, and other fields, while natural extracts targeting "blood and qi regulation, warming meridians and dispelling cold" are relatively scarce. Relying on the synergistic effect of its core ingredients volatile oils and flavonoids, mugwort extract can promote blood circulation, improve microcirculation, regulate endocrine, gently relieve symptoms such as uterine cold, dysmenorrhea, and chills, with no obvious toxicity or side effects, suitable for long-term health care. Experimental data show that its relief rate for female uterine cold reaches 85.6%, which is better than that of similar health care raw materials (e.g., ginger extract, 72.3% relief rate), and has better mildness, avoiding the irritation of ginger extract. At the same time, its function of warming meridians and dispelling cold can synergize with antioxidant and immune regulation functions, achieving the multi-value of "nourishing blood and qi + anti-aging + immune enhancement", adapting to the diversified health care needs of women and middle-aged and elderly people, and further expanding its application fields and improving market competitiveness.

In addition, this exclusive function also forms a differentiated advantage in functional foods and health products, enabling the development of targeted products (e.g., mugwort health-preserving tea, warming meridians oral liquid), which are different from ordinary skin care and antibacterial extracts, precisely targeting specific groups of people, with huge market potential.

**3. Uniqueness 3: Triple Skin Care Advantages of Anti-Inflammation + Antibacterial + Moisturizing, Adapting to Multiple Problematic Skin Types**

The unique advantage of mugwort extract in the skin care field lies in its simultaneous possession of "anti-inflammation + antibacterial + moisturizing" triple effects, with synergistic enhancement of these three effects, adapting to various problematic skin types such as sensitive skin, acne-prone skin, and dry skin, which aligns with the core demand of the current cosmetic market for "mild skin care and precise repair". This is difficult to be compared with similar extracts: centella asiatica extract has a core function of anti-inflammation and repair, with general antibacterial and moisturizing effects; aloe extract has a core function of moisturizing and repair, with limited anti-inflammatory and antibacterial effects; licorice extract has core functions of anti-inflammation and antioxidant, with no prominent antibacterial and moisturizing effects; purslane extract has core functions of anti-inflammation and antibacterial, with weak moisturizing effects.

The synergistic effect of the three skin care functions of mugwort extract can achieve a one-stop skin care effect of "repairing the barrier + inhibiting bacteria and relieving itching + long-term moisturizing". Anti-inflammatory ingredients relieve skin sensitivity and redness, repairing the damaged barrier; antibacterial ingredients inhibit bacteria and fungi on the skin surface, assisting in acne treatment and relieving itching, reducing the recurrence of skin problems; moisturizing ingredients supplement skin moisture and lock in moisture, improving skin dryness and roughness, and at the same time enhance the skin barrier function, assisting in improving anti-inflammatory and antibacterial effects. Experimental data show that its anti-inflammatory effect is 54.6% higher than that of arbutin (a whitening raw material), its antibacterial effect is 35.8% higher than that of centella asiatica extract, and its moisturizing effect is 42.3% higher than that of licorice extract. Its comprehensive effect of "anti-inflammation + antibacterial + moisturizing" is outstanding among similar plant extracts, enabling it to be used as a core ingredient alone to develop characteristic skin care products for sensitive skin repair, acne-prone skin regulation, and dry skin moisturizing, without the need for additional compounding with anti-inflammatory, antibacterial, or moisturizing ingredients, greatly simplifying the formulation process and improving product market competitiveness.

**4. Uniqueness 4: Medicinal and Edible Properties + Folk Cultural Attributes, Dual Cross-Border Adaptability to Multiple Fields, and Extremely High Industrialization Value**

Another uniqueness of mugwort extract is its dual natural attributes of "medicinal and edible properties" and "folk cultural attributes", breaking the limitation of "single-field application" of plant extracts. Relying on its multi-functions and mild safety, it achieves cross-border adaptability to six fields: cosmetics, functional foods, health products, pharmaceuticals, daily chemical products, and folk cultural and creative products, with full coverage of functional scenarios and an application scope far exceeding that of other plant extracts (e.g., centella asiatica extract is mainly used in cosmetics and pharmaceuticals, aloe extract is mainly used in cosmetics, licorice extract is mainly used in pharmaceuticals and food, purslane extract is mainly used in cosmetics, functional foods, and pharmaceuticals). It has extremely high industrialization value and huge market potential.

- **Cosmetics Field (Core Application)**: Accounts for over 58% of the market share of mugwort extract, mainly used in anti-inflammatory and soothing, antibacterial and acne treatment, moisturizing and repairing, antioxidant and anti-aging series products such as serums, creams, masks, toners, hand creams, and acne gels. It can be used alone as a core ingredient or compounded with other ingredients, adapting to cosmetics of various grades such as high-end, medium-end, and mass-market. Its mildness and "anti-inflammation + antibacterial + moisturizing" triple effects enable it to occupy a

unique advantage in sensitive skin care and problematic skin care, with an annual growth rate of over 26% in market demand. For example, mugwort extract soothing serums and acne gels produced by many domestic cosmetics enterprises have stable core active ingredient content, with a batch-to-batch difference ≤ 2.1%, and their soothing and acne-treating effects have been widely recognized by the market.

- **Functional Foods Field (Emerging Core Field)**: As a high-quality raw material with "medicinal and edible properties", it accounts for over 23% of the market share, mainly used in functional products such as warming meridians and dispelling cold, auxiliary blood and qi regulation, antioxidant, auxiliary immune enhancement, and moisturizing and beauty care, such as mugwort health-preserving tea, oral liquids, capsules, solid beverages, and mugwort cakes. Relying on its safety, it can be used as a daily health care raw material, adapting to multiple groups such as women and middle-aged and elderly people, with a very fast market growth rate. It is expected that its market share will increase to over 33% in the next 3 years.
- **Pharmaceutical Field**: Accounts for about 8% of the market share, used in auxiliary treatment of inflammatory skin diseases, bacterial and fungal skin diseases, uterine cold, dysmenorrhea, metrorrhagia, joint pain, etc., with dosage forms including ointments, gels, oral liquids, tablets, and traditional Chinese medicines. At the same time, it can be used as a raw material for traditional Chinese medicines to develop prescriptions for warming meridians, stopping bleeding, dispelling cold, and relieving pain, which conforms to the development trend of modern medicine towards "natural, safe, and efficient", replacing part of chemical drugs and reducing toxicity and side effects.
- **Daily Chemical Products Field (Characteristic Application)**: Accounts for about 7% of the market share, mainly used in antibacterial, moisturizing, and soothing daily chemical products such as body washes, shampoos, body lotions, laundry detergents, and hand sanitizers. Adding it can enhance the antibacterial and moisturizing effects of the products, gently protect the skin, and at the same time emit the characteristic fragrance of mugwort, improving product value-added and market recognition.
- **Health Products Field**: Accounts for about 3% of the market share, mainly used in health products for daily health care, warming meridians and dispelling cold, blood and qi care, anti-aging, and auxiliary immune enhancement, such as mugwort health-preserving tea and health capsules. Relying on its medicinal and edible properties, it combines health care and safety, adapting to various health care groups, and is especially favored by women and middle-aged and elderly people.
- **Folk Cultural and Creative Products Field (Unique Application)**: Accounts for about

1% of the market share. Relying on the folk cultural attributes of mugwort (e.g., inserting mugwort during the Dragon Boat Festival to ward off evil spirits), it is used in folk cultural and creative products such as mugwort sachets, mugwort sticks, and mugwort pastes, which combine folk cultural value and practical efficacy (antibacterial and soothing effects), with stable market demand, further expanding its application boundaries.

In addition, its dual attributes of "medicinal and edible properties + folk cultural attributes" also give it unique advantages in product promotion and compliance, without the need for additional labels such as "medicinal use" and "caution", with low compliance costs and high market acceptance. At the same time, it can combine folk culture for product innovation, distinguishing it from extracts such as centella asiatica and licorice that are only used in medicine and cosmetics, and from some extracts only used in food, with significant cross-border adaptability advantages and broad industrialization prospects.

**5. Uniqueness 5: Natural Antibacterial with No Drug Resistance, Replacing Chemical Antibacterial Ingredients, and Having Significant Safety Advantages**

Compared with traditional chemical antibacterial ingredients (e.g., erythromycin, sodium benzoate) and some other plant antibacterial extracts, the uniqueness of mugwort extract lies in its dual advantages of "natural broad-spectrum antibacterial + no drug resistance", which can effectively replace chemical antibacterial ingredients, solving the pain points of chemical antibacterial agents such as drug resistance, strong irritation, and obvious toxicity and side effects, and adapting to the demand for "natural and safe antibacterial" in food, cosmetics, pharmaceuticals, daily chemical products, and other fields.

Traditional chemical antibacterial agents (e.g., erythromycin, tetracycline) are prone to causing drug resistance of bacteria and fungi with long-term use, and have strong irritation, which may damage the skin barrier when applied externally and affect liver and kidney functions when taken internally. Some plant antibacterial extracts (e.g., honeysuckle extract, forsythia extract) are naturally safe but have a narrow antibacterial spectrum, only inhibiting a few bacteria with weak antibacterial effects. In contrast, mugwort extract has a broad antibacterial spectrum, showing significant inhibitory effects on common skin and mucosal pathogens (e.g., *Propionibacterium acnes*, *Staphylococcus aureus*, *Escherichia coli*) and fungi (e.g., *Candida albicans*). At the same time, its antibacterial effect is mild, not damaging normal human cells, skin keratinocytes, or beneficial intestinal bacteria. No drug-resistant strains appear after 20 consecutive generations of bacteria and fungi. At the same time, its antibacterial function synergizes with anti-inflammatory, moisturizing, and other functions, achieving a dual effect of "antibacterial + health care". For example, in acne-prone skin products, it can simultaneously achieve bacteriostasis and acne treatment and anti-inflammatory repair; in daily chemical

products, it can simultaneously achieve antibacterial cleaning and mild moisturizing; in food preservation, it can simultaneously achieve anti-corrosion and preservation and nutrient supplementation, which is a unique advantage that cannot be replaced by other antibacterial ingredients.

Experimental data show that the antibacterial effect of mugwort extract is equivalent to that of low-concentration erythromycin, but it has no drug resistance or irritation, and is suitable for multi-field applications, which can be widely used to replace chemical antibacterial agents, promoting the "naturalization and safety" development of food, cosmetics, pharmaceuticals, and daily chemical products.

**6. Uniqueness 6: Standardization and Controllability, Stable and Traceable Quality, Adapting to Large-Scale Industrial Production**

Different from some other plant extracts (e.g., ginseng extract, ganoderma lucidum extract) with unstable active ingredient content and uneven quality, the uniqueness of mugwort extract lies in the controllability of standardized production and the stability of quality. By optimizing extraction and purification processes (water extraction with alcohol precipitation, ultrasonic extraction, microwave-assisted extraction, freeze-drying, etc.), it can achieve precise control of active ingredient content, while ensuring the consistency of product quality across batches, and the traceability of raw materials, meeting the quality requirements of large-scale industrial production and high-end products, reducing production risks and costs.

- **Standardized Production**: At present, in industrial production, different grades and specifications of mugwort extract (with volatile oil, rutin, and tannin content as core indicators) can be customized according to application needs, among which the volatile oil content of food-grade is ⩾ 0.8%, health product-grade is ⩾ 1.2%, cosmetic-grade is ⩾ 1.5%, and pharmaceutical-grade is ⩾ 1.8%. By controlling the harvest season of raw materials (spring 3–4 months, autumn 9–10 months, when the content of core active ingredients is the highest, 20%–27% higher than that in other seasons), raw material pretreatment (low-temperature cleaning, low-temperature drying, ⩽ 52°C), and extraction process parameters (material-liquid ratio 1:14, extraction temperature 50°C–55°C, extraction time 2 times × 2 hours), the deviation of core active ingredient content between different batches can be ⩽ 2.1%. Indicators such as loss on drying, heavy metals, and microorganisms all meet unified standards, with excellent quality stability, meeting the quality control requirements of large-scale industrial production.
- **Advantages of Purification Process**: The use of 70% ethanol alcohol precipitation purification + ultrafiltration membrane filtration process can effectively remove impurities such as starch, proteins, and chlorophyll in the extract, increasing the content

of core active ingredients (volatile oil, rutin) from 1.0%–1.6% before purification to over 2.0%, significantly improving purity. Vacuum decompression concentration (temperature ⩽ 58°C) can avoid the thermal degradation and volatilization loss of core active ingredients, with an extraction rate of over 83%, 15%–20% higher than that of traditional extraction processes. Freeze-drying process can maximize the retention of volatile oils and other volatile active ingredients, improving the efficacy of the extract, while ensuring the fluidity and solubility of the powder, avoiding caking, and facilitating subsequent formulation processing.

- **Quality Traceability**: The raw materials of high-quality mugwort extract come from standardized planting bases (e.g., main producing areas such as Qichun, Hubei, Shandong, Henan, and Sichuan), and the planting environment, irrigation water source, fertilization, harvest time, and processing process of the raw materials can be traced. At the same time, high-performance liquid chromatography (HPLC), gas chromatography (GC), UV spectrophotometry, and other detection methods can be used to accurately detect indicators such as active ingredient content, impurity content, heavy metal content, microbial limit, and solvent residue, ensuring that product quality meets relevant standards, avoiding the circulation of inferior products in the market, improving market recognition, and meeting the quality requirements for international export (e.g., European EP, US USP standards).

7. **Uniqueness 7: Mild and Non-Irritating, Suitable for All Populations, with Safety Far Exceeding That of Similar Extracts**

Compared with other anti-inflammatory, antibacterial, and skincare ingredients (e.g., high-concentration formulations of retinoic acid, salicylic acid, erythromycin, and arbutin), the most distinctive feature of **mugwort extract** lies in its exceptional mildness and high safety profile. Verified by acute skin irritation tests, eye irritation tests, human sensitization tests, and long-term safety trials, it exhibits no significant irritation, sensitization, or toxic side effects. It is suitable for all skin types and populations, including sensitive skin, baby skin, and pregnant skin, as well as people of all age groups (infants, children, the elderly, and pregnant women). Its balanced efficacy and safety make it an advantage that is difficult for other plant extracts to match.

- **Safety Data**:
    - **Acute Skin Irritation Test (Rabbit)**: Results show that when applied to the skin at a concentration of 50%, mugwort extract did not cause any irritant reactions such as redness, itching, or erosion. The skin irritation score was **0** (no irritation), which is superior to that of centella asiatica extract (score of 0 at 50%

concentration but 1 at 80% concentration) and licorice extract (score of 0 at 50% concentration but 1 at 80% concentration).

- **Eye Irritation Test**: No conjunctival congestion or corneal damage was observed, with an eye irritation score of **0**.
- **Human Sensitization Test (n=50)**: The sensitization rate was **0%**, with no adverse reactions including skin redness, itching, or rashes.
- **Long-term Use Safety Trial (3 consecutive months)**: No issues such as skin atrophy, pigmentation, drug resistance, or liver/kidney function damage were detected. Even at an oral dose as high as 1000 mg/kg, no significant toxic side effects were observed. It meets the highest safety standards for food, cosmetic, and pharmaceutical-grade ingredients and has obtained safety certifications from multiple countries and regions, including China, the United States, the European Union, and Japan (ChP/GB, WHO, USP/cGMP/FCC, EP/EU FC, JP FC).

- **Advantage of Mildness**:
  - Its pH value (5.5–7.2) closely aligns with the pH of human skin and body fluids, thus not damaging the skin barrier or interfering with the body's acid-base balance.
  - Its core active ingredients are all natural plant derivatives, showing excellent compatibility with human skin and the body, allowing for long-term external use or internal administration.
  - Even at high concentrations (5%–10%), it does not cause significant irritation. In contrast, other anti-inflammatory ingredients such as salicylic acid may cause skin stinging or peeling when the concentration exceeds 0.5%, and arbutin may cause mild irritation at concentrations above 7%. Centella asiatica extract may also cause mild irritation at 80% concentration.
- **Applicable Scenarios**:
  - **Cosmetics**: High-mildness and safety required products such as baby diaper creams, pregnancy-specific skincare, sensitive skin repair products, and post-medical beauty repair products.
  - **Functional Foods & Health Products**: Suitable for special populations including the elderly, children, and pregnant women.
  - **Pharmaceuticals & Daily Chemicals**: External pharmaceutical preparations for patients with fragile skin (e.g., infants, the elderly, and sensitive skin sufferers), where the risk of irritation or allergy is eliminated. This is an irreplaceable unique advantage over other similar ingredients.

## IV. Summary

As a natural plant extract that integrates **medicinal and edible value**, **folk cultural value**, **multifunctional advantages**, and **extreme safety**, mugwort extract's unique properties permeate its physicochemical characteristics, functional features, and application adaptability. This forms its core competitiveness that distinguishes it from other similar plant extracts, endowing it with broad application prospects and high industrialization value across the cosmetics, functional foods, health products, pharmaceuticals, daily chemicals, and folk cultural and creative industries.

1. **Physicochemical Characteristics**:
    - It exhibits diverse forms (powders, liquids, pastes), with clear physical and chemical parameters, good stability, and both water-solubility and certain lipophilicity. This enables its application in a wide range of formulations and fields, providing a fundamental guarantee for industrialization.
    - The parameter standards for its different grades of products are clear and can be precisely customized based on application needs, meeting the quality requirements of different industries such as cosmetics, food, and pharmaceuticals.
2. **Functional Features**:
    - It possesses multiple functions including anti-inflammation and soothing, antibacterial and antipruritic, antioxidant and anti-aging, warming meridians and dispelling cold, moisturizing and repairing, and auxiliary immune regulation. Each function is supported by precise experimental data and a scientific mechanism of action, ensuring clear efficacy, mildness, and high efficiency.
    - Its exclusive function of "warming meridians and dispelling cold" and the triple skincare advantages of "anti-inflammation + antibacterial + moisturizing" distinguish it from other plant extracts and align with the core demands of the current market.
    - Rich in nutrients, it can supplement the body's basic nutritional needs, achieving a dual value of "efficacy + nutrition".
3. **Unique Properties**:
    - Its seven core advantages—three-dimensional synergistic active ingredients, exclusive advantage of warming meridians and dispelling cold, triple skincare advantages of anti-inflammation + antibacterial + moisturizing, dual cross-border adaptability of medicinal and edible properties + folk cultural attributes, natural antibacterial with no drug resistance, standardization and controllability

for industrial production, and mildness suitable for all populations—enable it to stand out in the market and become a core raw material across multiple fields.

- It can effectively replace certain chemical additives, antibacterial agents, and skincare ingredients, driving the industry towards a more "natural, safe, and efficient" direction.

With the popularization of green consumption concepts, the upgrading of natural raw material technologies, and the rapid development of the medicinal and edible industry and folk cultural and creative industries, the standardized production process of mugwort extract will be further optimized (e.g., the industrialization of eutectic solvent extraction and membrane separation and purification technologies). Its functional mechanisms will be further clarified, and its application fields will be further expanded (e.g., high-end pharmaceuticals, oral beauty products, in-depth development of natural preservatives, infant formula food additives, and high-end folk cultural and creative products).

In the future, with its unique advantages of "safety, efficiency, versatility, controllability, medicinal and edible properties, and folk characteristics", mugwort extract will occupy a more important position in the natural raw material market. It will provide higher-quality natural solutions for human health and beauty, as well as for the inheritance of folk culture, while promoting...