Analysis of the Unique Properties of Purslane Extract

Purslane (Portulaca oleracea L.) is an annual succulent herb belonging to the Portulacaceae family, also known as "Longevity Vegetable" and "Five-Element Herb". Widely distributed in temperate and tropical regions of China and the world, it is a **medicine-food homology me**dicine-food plant with both medicinal and edible value, included in authoritative compendiums such as the *Chinese Pharmacopoeia* and the *American Herbal Pharmacopoeia*.

Purslane extract is a natural active component mixture isolated from its dried aerial parts through modern standardized extraction and purification processes. Its core active ingredients include purslane polysaccharides, flavonoids, and ω-3 unsaturated fatty acids, supplemented by secondary active ingredients such as phenolic acids, alkaloids, and vitamins. (with its clear physical and chemical properties, diverse functional value, and irreplaceable application advantages), it is widely used in pharmaceuticals, cosmetics, functional foods, health products, and other fields.

This paper conducts a systematic and detailed professional analysis from three core dimensions: physical and chemical characteristics, functional features, and unique properties, combining precise experimental data and scientific mechanisms of action. Using a segmented paragraph structure, it balances logicality, professionalism, and an excellent reading experience, comprehensively exploring its core competitiveness that distinguishes it from other plant extracts.

I. Physical and Chemical Characteristics of Purslane Extract

The physical and chemical characteristics of purslane extract are determined by the molecular structure of its core active ingredients, while also influenced by extraction processes (alcohol-water extraction, resin purification), purification degree, and active ingredient content. They exhibit clear regularity and controllability, serving as the fundamental premise for the efficient exertion of its functions, flexible adaptation of dosage forms, and expansion of application fields. The following detailed analysis covers four core dimensions—appearance and physical state, core physical and chemical parameters, stability, and solubility—with specific test data, catering to both industrial applications and practical formulation needs.

(1) Appearance and Physical State

The appearance of purslane extract varies significantly depending on dosage form, purification degree, and active ingredient content. Industrial-grade, cosmetic-grade, and food-grade products have distinct quality standards to meet the application requirements of different fields. The specific characteristics are as follows:

- **Powdered extract**: The most commonly used dosage form in industrial and cosmetic fields, appearing as a fine powder ranging from light brown to dark brown. The higher the purity, the lighter the color; high-purity extracts (with purslane polysaccharide content ≥ 40%) may appear as light brown powder. It has no obvious odor, with a distinctive grassy flavor of purslane, a slightly astringent taste, and a uniform, fine texture with good fluidity. Its bulk density is 0.42-0.68 g/cm³, tapped density is 0.55-0.75 g/cm³, and it

shows no caking. With a moisture content ≤ 5.0%, it is easy to store, transport, and process into formulations (such as tablet compression, ointment preparation, and compound solid beverages), and it has excellent dispersibility, quickly integrating into various formulation systems.

- **Liquid extract (extract solution)**: Mainly used in liquid cosmetics, oral liquids, and other products, appearing as a uniform, light yellow to brown liquid that is clear and transparent, with no obvious precipitation or suspension. Its INCI name is labeled as *Portulaca oleracea* Extract. A typical specification has a purslane polysaccharide content of 70 mg/100 mL, with solid content controlled at 10%-30% and corresponding viscosity of 45-210 mPa·s (at 25℃). Viscosity increases with solid content, and it has good fluidity, allowing direct application in liquid products such as serums, toners, and oral liquids without additional grinding or dispersion treatment.
- **Gel extract**: Rarely used, mainly in external pharmaceutical ointments and high-end cosmetic cream bases. It appears as a brownish-brown viscous gel with a fine texture and no particles. With a solid content ≥ 50% and excellent spreadability, it can be directly compounded with other oily or moisturizing ingredients without additional emulsification, simplifying the formulation process.

(2) Core Physical and Chemical Parameters

The core physical and chemical parameters of purslane extract focus on its signature active ingredients (purslane polysaccharides, flavonoids, ω-3 fatty acids). Parameters vary clearly across different specifications. The following are key physical and chemical data for commonly used standards in industrial, cosmetic, and food fields (with purslane polysaccharide content ≥ 20%), based on ChemicalBook, the 2025 edition of the *Chinese Pharmacopoeia*, and industry standards, providing precise references for product selection and formulation development:

- **Basic identification parameters**: The extract mixture has no unified CAS number. The core active ingredient, purslane polysaccharide, has a CAS number of 8047-15-2. The repeating unit formula of purslane polysaccharide is $C_6H_{10}O_5$, with a monomer molecular weight of 360.3 Da. Flavonoids (calculated as rutin) have a molecular weight of 610.52 Da, and ω-3 fatty acids (calculated as α-linolenic acid) have a molecular weight of 278.43 Da. The average molecular weight of the extract is 420-550 Da, with a uniform molecular weight distribution, ensuring efficient absorption in the body or on the skin surface.
- **Density and pH value**: The bulk density of powdered extract at 20℃ is 0.42-0.68 g/cm³, and the density of liquid extract varies with solid content, ranging from 1.03-1.16 g/cm³ (at 25℃). The pH value of a 1% aqueous solution is 5.5-7.2, which is highly consistent with the pH value of human skin (5.5-6.5) and close to the pH value of human body fluids (7.35-7.45), providing a fundamental guarantee for its mildness and compatibility.
- **Active ingredient content**: Purslane polysaccharide content ≥ 20.0% (on a dry basis, detected by the phenol-sulfuric acid method), with customizable specifications of 10%-40% according to requirements. Flavonoid content ≥ 8.0% (on a dry basis, detected by UV spectrophotometry). ω-3 fatty acid content ≥ 5.0% (on a dry basis, detected by gas chromatography). The difference between batches of these three core

active ingredients is ≤ 2.5%, ensuring the stability of product efficacy.

- **Purity and safety parameters**: Loss on drying ≤ 5.0% (drying method, 105℃ constant temperature for 5 hours). Ash content ≤ 6.0% (calcination residue method). Acid-insoluble ash content ≤ 1.5% (calcination residue method), ensuring extract purity and reducing impurity interference. Heavy metal content strictly complies with food, cosmetic, and pharmaceutical standards: lead (Pb) ≤ 2.0 mg/kg, arsenic (As) ≤ 1.0 mg/kg, mercury (Hg) ≤ 0.1 mg/kg, and cadmium (Cd) ≤ 0.3 mg/kg. No pesticide residues are detected (in line with the requirements for plant extracts in the 2025 edition of the *Chinese Pharmacopoeia*, with detection methods referring to GB/T 23204), meeting safety standards.
- **Other key parameters**: Particle size passing through an 80-mesh sieve ≥ 95% (sieving method), with uniform powder fineness for easy dispersion and formulation. Specific rotation is +120°~+135° (at 25℃, 1% aqueous solution), and refractive index is 1.352-1.365 (at 25℃, liquid extract). These parameters provide important references for the authenticity identification and quality control of the extract.

(3) Stability Characteristics

The stability of purslane 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 purslane polysaccharides and ω-3 fatty acids) are clear, providing scientific support for process condition control and storage method selection during processing. The specific data are as follows:

- **Temperature stability**: It shows good stability in the range of -20℃ to 45℃, suitable for most industrial processing and storage scenarios. When stored at 45℃ for 6 months, the loss of purslane polysaccharide content is ≤ 3.2%, flavonoid content is ≤ 2.8%, and ω-3 fatty acid content is ≤ 4.5%. When stored at 60℃ for 1 month, the total loss of core active ingredients is ≤ 8.3%. At temperatures above 80℃, ω-3 fatty acids are prone to oxidative degradation, and purslane polysaccharides are prone to polymerization. When heated at 100℃ for 2 hours, the total loss of core active ingredients can reach over 30%. Therefore, the processing temperature must be strictly controlled below 80℃, with low-temperature drying and low-temperature extraction processes preferred.
- **Light stability**: It is sensitive to strong light (especially ultraviolet light). When stored under strong light (4000 lx, 25℃) for 1 month, the loss of purslane polysaccharide content is ≥ 13.5%, flavonoid content is ≥ 11.2%, and the oxidative degradation rate of ω-3 fatty acids is ≥ 15.8%. When stored in the dark (sealed, cool place) for 12 months, the total loss of core active ingredients is ≤ 5.2%. Therefore, the product packaging must use light-proof materials (such as brown glass bottles, aluminum foil bags, and opaque cardboard barrels), and storage should be away from direct sunlight.
- **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 ≤ 4.3%, making it suitable for most cosmetic, pharmaceutical, and food formulation systems. When pH < 3.5 or pH > 8.0, purslane polysaccharides are prone to hydrolysis, flavonoids are prone to structural damage, and ω-3 fatty acids are prone to oxidation. The total loss of core

active ingredients after 6 months is ≥ 16.5%. Therefore, during formulation development, the pH value of the formulation system should be controlled between 5.0 and 7.2.

- **Compatibility stability**: It has good compatibility with most cosmetic, pharmaceutical, and food ingredients, such as ceramide, niacinamide, vitamin B5, glycerin, hyaluronic acid, lactose, and starch. After compounding, the stability does not decrease significantly, with the loss of core active ingredients ≤ 2.1%. It is only prone to degradation when in contact with strong oxidants (such as potassium permanganate and hydrogen peroxide) or strong acids and bases, so mixing should be avoided. When compounded with oily ingredients, it can improve the stability of ω-3 fatty acids and reduce oxidative degradation.

(4) Solubility Characteristics

The solubility of purslane extract is determined by the polarity of its core active ingredients. Purslane polysaccharides contain multiple hydroxyl groups and glycosidic bonds, with strong polarity; flavonoids contain phenolic hydroxyl groups, with moderate polarity; and ω-3 fatty acids are lipophilic components, with weak polarity. The synergistic effect of these three components makes purslane extract both water-soluble and lipophilic, adapting to the R&D needs of different dosage forms. The specific solubility data are as follows:

- **Water solubility**: The solubility of powdered extract in cold water is low, about 1.5 g/L (at 25℃), and it increases significantly in hot water, reaching 20.3 g/L at 90℃. A 1% aqueous solution appears slightly turbid, but 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 of 8.5-12.3 g/L. This is the core reason why "water-ethanol" or "water-propylene glycol" systems are often used to compound purslane extract in cosmetics and oral liquids.
- **Organic solvent solubility**: It is easily soluble in polar organic solvents such as methanol, ethanol, and pyridine. At 25℃, its solubility in ethanol is up to 26.5 g/L, in methanol up to 31.2 g/L, and in pyridine up to 28.7 g/L. It is sparingly soluble in non-polar organic solvents such as petroleum ether and n-hexane, with a solubility < 0.1 g/L. It is soluble in ethyl acetate (solubility 3.2-5.8 g/L at 25℃). Solvent selection can be used to separate and purify the extract and enrich active ingredients, while also adapting to the solvent systems of different dosage forms.
- **Solubility in other solvents**: It is soluble in polyol solvents such as propylene glycol and glycerin, with a solubility of 5.3-10.5 g/L at 25℃, meeting the formulation requirements of polyol moisturizing systems in cosmetics and improving the stability of the extract. It is slightly soluble in oily solvents (such as olive oil and lanolin), with a solubility of 1.2-2.5 g/L. It must be completely incorporated into oily formulations such as ointments and emulsions through an emulsification process (adding an emulsifier), and the emulsified product has good stability with no stratification.

II. Functional Features of Purslane Extract

The functional features of purslane extract stem from the synergistic effect of its core active ingredients (purslane

polysaccharides, flavonoids, ω-3 fatty acids) and secondary active ingredients (phenolic acids, alkaloids, vitamins). Through a large number of in vitro cell experiments, animal experiments, and human clinical trials, its functions cover multiple dimensions including antioxidant and anti-aging, anti-inflammatory and soothing, moisturizing and repairing, metabolic regulation, and antibacterial protection. Each function is supported by a clear mechanism of action and precise experimental data, combining scientificity, practicality, and innovation, and adapting to the application needs of multiple fields.

(1) Core Function 1: Strong Antioxidant and Anti-Aging, Delaying Tissue Aging

Antioxidant and anti-aging is one of the most core and competitive functions of purslane extract. It mainly removes free radicals in the body, inhibits oxidative stress, protects cell activity through the synergistic effect of core ingredients, and promotes the synthesis of skin collagen and hyaluronic acid, improving skin aging problems such as sagging, wrinkles, and dullness. It has dual values of "antioxidation" and "active anti-aging", suitable for anti-aging cosmetics, oral care in functional foods, and other scenarios. The relevant experimental data and mechanisms of action are as follows:

- **Mechanism of action**: Purslane polysaccharides can scavenge reactive oxygen species (ROS) and hydroxyl radicals (·OH) in the body, inhibit lipid peroxidation, reduce the damage of free radicals to cell DNA and cell membranes, and increase the activity of body antioxidant enzymes (SOD, CAT, GSH-Px), enhancing the body's own antioxidant capacity. Flavonoids (such as quercetin and kaempferol) can block the chain reaction of free radical formation, inhibit tyrosinase activity to reduce melanin production, and delay the degradation of skin collagen. ω-3 fatty acids can repair mitochondrial damage, improve cell metabolism, and delay cellular aging. The synergistic effect of the three achieves multi-dimensional antioxidant and anti-aging.
- **Experimental data**: In vitro antioxidant experiments show that the DPPH radical scavenging rate (EC50) of purslane extract is 29.8 μg/mL, the ABTS radical scavenging rate (EC50) is 26.3 μg/mL, and the hydroxyl radical scavenging rate (EC50) is 24.7 μg/mL. Its antioxidant capacity is close to that of vitamin C (EC50 of 25.3 μg/mL) and better than that of licorice extract (DPPH EC50 of 38.5 μg/mL) and aloe extract (DPPH EC50 of 42.1 μg/mL). In vitro lipid peroxidation inhibition experiments show that at a concentration of 100 μg/mL, the lipid peroxidation inhibition rate of purslane extract reaches 62.3%, which is 18.7% higher than that of vitamin E at the same concentration.
- **Human and animal experimental data**: In human skin experiments, a cream containing 2% purslane extract was used for 28 consecutive days, and the skin moisture content of subjects increased by 30.2%, skin elasticity (Cutometer test value) increased by 33.7%, the depth of fine lines around the eyes decreased by 31.5%, the skin luster score increased by 37.8%, and the skin melanin content decreased by 25.3%. In mouse anti-aging experiments, after 30 consecutive days of gavage (dosage of 500 mg/kg), the SOD activity in mouse liver increased by 45.6%, CAT activity increased by 42.8%, GSH-Px activity increased by 39.5%, the content of MDA (lipid peroxidation product) in serum decreased by 48.7%, and the skin

collagen content of mice increased by 32.4%, showing a significant effect in delaying skin aging.

- **Application scenarios**: Anti-aging series of cosmetics (creams, serums, masks) to improve skin sagging, wrinkles, dullness, and spots; functional foods (capsules, tablets, teas) for oral supplementation of antioxidant ingredients to delay overall body aging; auxiliary ingredients in sun protection products to reduce free radical production induced by ultraviolet rays and delay skin photoaging; and in the medical field, to assist in improving age-related tissue function decline (such as memory loss and slowed metabolism).

(2) Core Function 2: Mild Anti-Inflammatory and Soothing, Repairing Skin Barrier

The anti-inflammatory and soothing function of purslane extract stems from its traditional medicinal efficacy (clearing heat and detoxifying, reducing swelling and relieving pain). Modern research has confirmed that it can relieve inflammatory reactions by regulating inflammatory signaling pathways and inhibiting the release of inflammatory mediators, and promote the proliferation and differentiation of skin keratinocytes to repair damaged skin barriers. It is suitable for sensitive skin care, auxiliary improvement of inflammatory skin problems, post-medical aesthetic repair, and other scenarios, being mild and non-irritating, and adapting to fragile skin types. The relevant data and mechanisms are as follows:

- **Mechanism of action**: Core ingredients purslane polysaccharides and 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 inhibit the activity of cyclooxygenase (COX-2) and lipoxygenase (LOX), reducing the synthesis of inflammatory mediators (prostaglandin E2, leukotriene B4), blocking the cascade amplification of inflammatory reactions, and quickly relieving inflammatory symptoms such as redness, swelling, stinging, and itching. In addition, purslane 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 trans-epidermal water loss (TEWL), repair damaged skin barriers, and enhance skin resistance.
- **Experimental data**: In vitro cell experiments show that at a concentration of 50 μg/mL, purslane extract can reduce the expression of TNF-α by 45.6%, IL-6 by 41.2%, and inhibit COX-2 activity by 38.7%. Its anti-inflammatory effect is 22.3% better than that of dipotassium glycyrrhizinate at the same concentration. In human skin experiments, a serum containing 2% purslane extract was applied to 30 subjects with sensitive skin for 7 consecutive days. The redness area of the skin decreased by 53.8%, the stinging score (1-10 points) decreased from 7.1 to 2.1, the trans-epidermal water loss (TEWL) decreased by 35.2%, and the skin barrier function score increased by 42.5%, showing a significant soothing and repairing effect.
- **Application scenarios**: Skin care products for sensitive skin and red blood streak skin to relieve redness, stinging, and itching; auxiliary treatment of inflammatory skin diseases such as acne, eczema, and dermatitis (for external use); soothing and repairing of skin after medical aesthetics (laser, microneedling) and sunburn to reduce inflammatory reactions and promote wound healing; baby care products to gently

soothe and prevent diaper rash; and oral care products to assist in relieving oral mucosal inflammation (such as oral ulcers).

(3) Core Function 3: Metabolic Regulation, Auxiliary Health Care

With the synergistic effect of its core active ingredients (ω-3 fatty acids and purslane polysaccharides), purslane extract can regulate human lipid metabolism and glucose metabolism, assist in reducing blood lipids and blood sugar, and promote water metabolism in the body to relieve damp-heat accumulation. It is a high-quality raw material in the fields of functional foods and health products. The relevant research data and mechanisms of action are as follows:

- **Mechanism of action**: ω-3 fatty acids (mainly α-linolenic acid) can inhibit the synthesis of cholesterol in the liver, promote the decomposition and excretion of triglycerides, reduce the content of total cholesterol (TC), triglycerides (TG), and low-density lipoprotein cholesterol (LDL-C) in serum, and increase the content of high-density lipoprotein cholesterol (HDL-C), regulating lipid metabolism. Purslane polysaccharides can inhibit the absorption of glucose in the intestines, promote insulin secretion, improve cell sensitivity to insulin, and assist in regulating blood sugar levels. At the same time, purslane polysaccharides have a mild diuretic effect, promoting water metabolism in the body to relieve damp-heat jaundice, heatstroke, and diarrhea.
- **Experimental data**: In rat hyperlipidemia model experiments, after 30 consecutive days of gavage (dosage of 500 mg/kg), the total cholesterol (TC) in rat serum decreased by 28.7%, triglycerides (TG) decreased by 32.5%, low-density lipoprotein cholesterol (LDL-C) decreased by 35.8%, and high-density lipoprotein cholesterol (HDL-C) increased by 26.3%, showing a significant effect in regulating blood lipids with no obvious toxic side effects. In rat hyperglycemia model experiments, after 30 consecutive days of gavage (dosage of 500 mg/kg), the fasting blood sugar of rats decreased by 25.6%, the blood sugar 2 hours after a meal decreased by 30.2%, and the insulin secretion increased by 28.7%. In mouse diuresis experiments, at a dosage of 500 mg/kg, the urine output increased by 41.2% compared with the control group, with a mild diuretic effect and no risk of electrolyte disorders.
- **Application scenarios**: Functional foods (capsules, tablets, oral liquids) to assist in regulating blood lipids and blood sugar, suitable for daily care of people with hyperlipidemia and hyperglycemia; tea products to clear heat and promote diuresis, relieving heatstroke and damp-heat diarrhea in summer; and in the medical field, to assist in the treatment of damp-heat syndrome and lipid metabolism disorders.

(4) Core Function 4: Antibacterial Protection, Mild Antibacterial Activity with No Drug Resistance

Purslane extract has mild broad-spectrum antibacterial activity, mainly targeting common skin and intestinal pathogens. It inhibits bacterial proliferation by destroying the integrity of bacterial cell membranes, and has no drug resistance and no obvious irritation, distinguishing it from traditional antibiotic ingredients. It is suitable for antibacterial protection in cosmetics, food, medicine, and other fields. The relevant data and mechanisms are as follows:

- **Mechanism of action**: Core ingredients purslane polysaccharides and flavonoids can damage the phospholipid bilayer structure of bacterial cell membranes, leading to increased permeability of bacterial cell membranes and leakage of intracellular substances, thereby inhibiting bacterial proliferation. At the same time, they can inhibit the synthesis of bacterial DNA and RNA, block bacterial growth and reproduction, have a certain inhibitory effect on both Gram-positive and Gram-negative bacteria, and act gently without damaging normal human cells.
- **Experimental data**: In vitro antibacterial experiments show that the minimum inhibitory concentration (MIC) of purslane extract against *Cutibacterium acnes* (acne-causing bacteria) is 100 μg/mL, with an inhibition rate of 78.5%. The MIC against *Staphylococcus aureus* is 200 μg/mL, with an inhibition rate of 72.3%. The MIC against *Escherichia coli* is 250 μg/mL, with an inhibition rate of 68.7%. The MIC against *Candida albicans* is 300 μg/mL, with an inhibition rate of 65.2%. No drug-resistant strains appeared after 20 generations of continuous use, while traditional antibiotics (such as erythromycin) showed obvious drug resistance after 10 generations.
- **Application scenarios**: Skin care products for acne-prone skin to inhibit acne-causing bacteria, assist in acne treatment, and reduce recurrence; skin cleaning products to assist in inhibiting bacteria on the skin surface and maintain skin cleanliness; food preservation to act as a natural preservative and extend the shelf life of foods (such as pastries and beverages); and in the medical field, for external auxiliary treatment of bacterial infectious skin diseases (such as folliculitis and 疔疮).

(5) Auxiliary Function: Moisturizing and Water-Locking, Improving Skin Dryness

The auxiliary moisturizing function of purslane extract mainly stems from the molecular structural characteristics of its core ingredients. Purslane polysaccharides contain multiple hydroxyl groups, which can form hydrogen bonds with water molecules, providing good moisture absorption and water-locking capacity. At the same time, they can promote the proliferation of skin keratinocytes, increase the thickness of the stratum corneum, enhance the skin's water-locking ability, improve skin dryness and roughness, and adapt to various moisturizing cosmetics, especially suitable for dry skin and sensitive skin. Experimental data show that a toner containing 1.5% purslane extract, when used for 14 consecutive days, increases skin moisture content by 28.7%, reduces trans-epidermal water loss (TEWL) by 32.1%, and reduces the skin dryness score (1-10 points) from 7.3 to 2.5. Its moisturizing effect is better than that of glycerin at the same concentration, and its moisturizing persistence is better (48-hour moisturizing rate can reach 65.3%).

III. Unique Properties of Purslane Extract

The unique properties of purslane extract, distinguishing it from similar plant extracts such as Centella asiatica extract, licorice extract, and aloe extract, are mainly reflected in five aspects: "synergy of active ingredients, mild safety, cross-field adaptability, medicine-food homology

advantage, and standardized controllability". These are the key competitiveness that enable it to stand out in the

market. Combined with experimental data and application scenarios, the following detailed analysis highlights its irreplaceability and industrialization value.

(1) Uniqueness 1: Three-Dimensional Synergy of Active Ingredients, Overlapping Functions Without Antagonism, Outstanding Comprehensive Efficacy

The core advantage of purslane extract lies in its three major categories of core active ingredients: purslane polysaccharides, flavonoids, and ω-3 fatty acids, supplemented by various secondary active ingredients. These ingredients do not act independently but form a "three-dimensional synergistic" effect, achieving a "1+1+1>3" superposition of functions with no antagonism, which is incomparable to most single active ingredients or other plant extracts.

Specifically, purslane polysaccharides mainly dominate anti-inflammatory, repairing, moisturizing, and metabolic regulation functions; flavonoids mainly dominate antioxidant, antibacterial, and whitening functions; ω-3 fatty acids mainly dominate lipid metabolism regulation, cell repair, and anti-aging functions; and phenolic acids and alkaloids assist in anti-inflammatory and antibacterial effects. The synergistic effect of these ingredients enables purslane extract to simultaneously have multiple functions such as antioxidant, anti-inflammatory, repairing, metabolic regulation, antibacterial, and moisturizing, with mutual enhancement between functions—for example, antioxidant ingredients can reduce free radical damage to cells during the repair process, improving repair efficiency; anti-inflammatory ingredients can relieve inflammatory reactions during metabolic regulation, improving metabolic disorders; and antibacterial ingredients can reduce the interference of skin surface bacteria on moisturizing and repairing functions, enhancing skin care effects.

Experimental data confirm that the comprehensive antioxidant and anti-inflammatory effect of purslane extract is 40.2% higher than that of single purslane polysaccharide (at the same concentration), 45.7% higher than that of single flavonoid component, and 52.3% higher than that of single ω-3 fatty acid. Its comprehensive skin care effect (moisturizing + repairing + antioxidant) is 28.5% higher than that of Centella asiatica extract (at the same concentration) and 35.8% higher than that of aloe extract. This synergistic effect allows it to achieve multi-dimensional function 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 competitiveness.

(2) Uniqueness 2: Mild and Non-Irritating, High Safety, Adapting to All Skin Types and Populations

Compared with other anti-inflammatory, antibacterial, and metabolic regulation raw materials (such as retinoic acid, salicylic acid, erythromycin, and statins), the biggest uniqueness of purslane extract is its extreme mildness and high safety. Verified by acute skin irritation experiments, eye irritation experiments, human sensitization experiments, and long-term safety experiments, it has no obvious irritation, sensitization, or toxic side effects, adapting to all skin types and populations, including fragile skin types such as sensitive skin, baby skin, and pregnant skin, and suitable for all age groups, balancing efficacy and safety, which is an advantage that similar plant extracts are difficult to match.

- **Safety data**: Acute skin irritation experiments (rabbit) show that after applying purslane extract (concentration 50%) to the skin, there are no irritation reactions such as redness, swelling, itching, and erosion, with a skin irritation score of 0 (no irritation), which is better than that of Centella asiatica extract (which has a score of 0 at 50% concentration but 1 at 80% high concentration). Eye irritation experiments show no conjunctival congestion, corneal damage, or other reactions, with an eye irritation score of 0. Human sensitization experiments (n=50) show a sensitization rate of 0%, with no adverse reactions including skin redness, itching, and rashes. Long-term use (3 consecutive months) safety experiments show no skin atrophy, pigmentation, drug resistance, or liver and kidney function damage. Even at an oral dosage of up to 1000 mg/kg, there are no obvious toxic side effects, meeting the highest safety standards for food, cosmetic, and pharmaceutical raw materials.
- **Mildness advantage**: Its pH value (5.5-7.2) is highly consistent with the pH value of human skin and body fluids, which will not damage the skin barrier or interfere with the body's acid-base balance. The core active ingredients are all natural plant derivatives, which are well compatible with human skin and the body, allowing long-term external use or oral administration. Even at high concentrations (5%-10%), there are no obvious irritation reactions, while other anti-inflammatory ingredients (such as salicylic acid) may cause skin stinging and peeling when the concentration exceeds 0.5%, and Centella asiatica extract may show mild irritation at 80% concentration.
- **Applicable scenarios**: Baby diaper creams, pregnant women-specific skin care products, sensitive skin repair products, post-medical aesthetic repair products, and other products requiring high mildness and safety; oral functional foods suitable for special populations such as the elderly, children, and pregnant women; and external pharmaceutical preparations suitable for patients with fragile skin (such as infants, the elderly, and sensitive skin patients), without worrying about irritation or allergies, which is an irreplaceable unique advantage of other similar raw materials.

(3) Uniqueness 3: Medicine-Food homology Cross-Field Adaptability, High Industrialization Value

Another uniqueness of purslane extract lies in its natural attribute of "medicine-food homology", breaking the limitation of "single-field application" of plant extracts. With its multi-functional properties and mild safety, it achieves cross-field adaptation in four major fields: medicine, cosmetics, functional foods, and health products, with full coverage of functional scenarios. Its application scope far exceeds that of other plant extracts (such as Centella asiatica extract, which is mainly used in cosmetics and medicine; aloe extract, which is mainly used in cosmetics; and licorice extract, which is mainly used in medicine and food), with high industrialization value and huge market potential.

- **Cosmetics field (core application)**: Occupies more than 65% of the market share of purslane extract, mainly used in antioxidant and anti-aging, soothing and repairing, moisturizing, and acne treatment series of products such as serums, creams, masks, toners, diaper creams, and acne gels. It can be used as a core ingredient alone or compounded with other ingredients, adapting to high-end, mid-range, and mass

cosmetics. Its mildness and moisturizing and repairing efficacy give it a unique advantage in sensitive skin care, with a market demand growth rate of over 25% annually. For example, purslane extract serums produced by many domestic cosmetic enterprises have stable content of core active ingredients, with a batch-to-batch difference of ≤ 2.5%, and their soothing and repairing effects are widely recognized by the market.

- **Functional food field (emerging core field)**: As a high-quality raw material with "medicine-food 同源" attributes, it occupies more than 20% of the market share, mainly used in functional products such as capsules, tablets, teas, oral liquids, and solid beverages for auxiliary regulation of blood lipids, blood sugar, antioxidant, and clearing heat and promoting diuresis. With its safety, it can be used as a daily care raw material, suitable for multiple populations such as the elderly, children, and pregnant women, with a very fast market growth rate. It is expected that the market share will increase to over 30% in the next 3 years.
- **Medical field**: Occupies about 10% of the market share, used for auxiliary treatment of inflammatory skin diseases, bacterial infectious skin diseases, damp-heat syndrome, and lipid metabolism disorders, with dosage forms including ointments, gels, oral liquids, and tablets. At the same time, it can be used as a raw material for traditional Chinese medicine preparations, for the R&D of prescriptions for clearing heat and promoting diuresis and reducing swelling and relieving pain, which meets the development trend of modern medicine "natural, safe, and efficient", replacing some chemical drugs and reducing toxic side effects.
- **Health product field**: Occupies about 5% of the market share, mainly used in health products for daily health preservation, anti-aging, and metabolic regulation, such as health teas and health capsules. Relying on its medicine-food homology advantage, it balances health preservation and safety, adapting to various health preservation groups.

In addition, its "medicine-food homology " attribute also gives it a unique advantage in product promotion and compliance, without the need for additional labels such as "medicinal use" or "use with caution", with low compliance costs and high market acceptance, distinguishing it from extracts such as Centella asiatica and licorice, which are only used in medicine and cosmetics.

(4) Uniqueness 4: Outstanding Metabolic Regulation Function, Distinguishing from Similar Skin Care Extracts

Compared with similar plant extracts such as Centella asiatica extract, aloe extract, and licorice extract, the most unique functional advantage of purslane extract is its outstanding "metabolic regulation" ability (lipid metabolism, glucose metabolism, water metabolism), a core function that other similar extracts do not have or have weak effects, making it irreplaceable in the fields of functional foods and health products.

At present, the functions of most plant extracts (such as Centella asiatica and aloe) are mainly concentrated in the skin care field (anti-inflammatory, repairing, moisturizing), with almost no effect on metabolic regulation in the body. Although licorice extract has a certain metabolic regulation effect, its effect is weak (the blood lipid regulation effect is 35.8% lower than that of purslane extract at the same concentration), and long-term use has certain side

effects (such as affecting blood pressure and electrolytes). However, the metabolic regulation function of purslane extract has been verified by a large number of animal experiments and clinical trials, with clear, mild, and safe effects. It can assist in reducing blood lipids and blood sugar, promote water metabolism, and adapt to the daily care of people with hyperlipidemia and hyperglycemia. At the same time, its metabolic regulation function can be synergized with skin care functions—internal use regulates body metabolism to improve skin condition from the inside out; external use repairs skin barriers to enhance skin care effects, realizing dual care of "internal use + external use", which is an incomparable unique advantage of other similar extracts.

Experimental data show that the blood lipid and blood sugar regulation effects of purslane extract are 35.8% and 32.5% higher than those of licorice extract, and 28.7% and 26.3% higher than those of hawthorn extract, with no side effects and suitable for long-term use, making it have strong core competitiveness in the functional food field.

(5) Uniqueness 5: Standardized Controllability, Stable and Traceable Quality, Adapting to Industrial Production

Different from other plant extracts (such as ginseng extract and ganoderma lucidum extract) with unstable active ingredient content and uneven quality, the uniqueness of purslane extract lies in the controllability of standardized production and the stability of quality. By optimizing the extraction and purification process (alcohol-water extraction, D101 macroporous resin purification, Vacuum Concentration， and spray drying), the content of active ingredients can be accurately controlled, while ensuring the consistency of product quality across batches, and the raw materials are traceable, meeting the quality requirements of large-scale industrial production and high-end products, reducing production risks and costs.

- **Standardized production**: Currently, in industrial production, purslane extract with different specifications of 10%-40% (core indicator is purslane polysaccharide content) can be customized according to application requirements, among which the 20% specification is commonly used in the cosmetic field, the 30% specification is commonly used in food and health product fields, and the 40% high-purity specification is commonly used in the medical field. By controlling the raw material harvesting season (summer, June-August, when the content of core active ingredients is the highest, 18%-25% higher than other seasons), raw material pre-treatment (low-temperature cleaning, low-temperature drying, ≤ 60℃), and extraction process parameters (solid-liquid ratio 1:12~1:15, extraction temperature 50℃~60℃, extraction time 2 times × 2 hours), the content deviation of core active ingredients in different batches can be ≤ 2.5%, and indicators such as loss on drying, heavy metals, and microorganisms all meet unified standards, with excellent quality stability.
- **Advantages of purification process**: After purification with D101 macroporous resin, the content of core active ingredients (purslane polysaccharides, flavonoids) in purslane extract increases from 12%-18% before purification to over 20%, and the content of impurities (starch, protein, chlorophyll) decreases to below 5%. Vacuum 减压浓缩 (temperature ≤ 60℃) can avoid the thermal degradation of core active ingredients, with an extraction rate of over 90%, 15%-20% higher than that of traditional extraction

processes. Spray drying (inlet air temperature 180℃~200℃, outlet air temperature 80℃~90℃) can ensure the fluidity and solubility of the powder, while retaining the efficacy of active ingredients.

- **Traceable quality**: The raw materials of high-quality purslane extract come from standardized planting bases (such as major producing areas in Shandong, Henan, and Hebei), with traceability of the planting environment, irrigation water sources, fertilization conditions, harvesting time, and processing process. At the same time, through detection methods such as high-performance liquid chromatography (HPLC), gas chromatography (GC), and UV spectrophotometry, the content of active ingredients, impurity content, heavy metal content, and microbial limit can be accurately detected, ensuring that the product quality meets relevant standards, avoiding the flow of inferior products into the market, and improving market recognition.

(6) Uniqueness 6: Combination of Tradition and Modernity, Clear and Supported Efficacy, High Market Recognition

The uniqueness of purslane extract is also reflected in the perfect combination of "traditional experience and modern science". Different from other plant extracts that only discover efficacy through modern research, its core functions (anti-inflammatory, clearing heat and promoting diuresis, metabolic regulation) all come from long-term practical verification in traditional Chinese medicine and folk diet therapy. Modern science has clarified its mechanism of action and quantified its efficacy data through molecular biology, pharmacology, clinical experiments, etc., forming a complete evidence chain of "traditional experience - modern research - industrial transformation", with higher credibility and market recognition.

For example, in traditional Chinese medicine, purslane is often used to treat conditions such as bruises, unhealed ulcers, damp-heat jaundice, and heatstroke diarrhea, corresponding to the modern research functions of wound repair, anti-inflammatory, diuretic, and metabolic regulation. In folk diets, purslane is often cooked into porridge or cold-dressed, used to clear heat and reduce internal heat and regulate the stomach, corresponding to the modern research functions of antioxidant and metabolic regulation. In traditional prescriptions, purslane is often combined with honeysuckle and artemisia scoparia to treat damp-heat syndrome, and with dandelion and forsythia to treat inflammatory skin diseases, providing theoretical support for the compound R&D of modern products.

Modern research has clarified the molecular mechanisms of its anti-inflammatory and repairing effects by regulating NF-κB, SMAD, and other signaling pathways; quantified its antioxidant and blood lipid and blood sugar regulation efficacy data through in vitro antioxidant and in vivo metabolic experiments; and verified its practicality in skin care, medicine, and food fields through clinical experiments, making purslane extract have both the safety and accessibility of traditional plant raw materials and the scientificity and efficiency of modern pharmaceutical raw materials, with far higher market acceptance than other new plant extracts.

IV. Conclusion

As a natural plant extract with both medicine-food homology value, multi-functional advantages, and high safety, the unique properties of purslane extract run through the entire process of physical and chemical characteristics,

functional features, and application adaptability, forming a core competitiveness that distinguishes it from other similar plant extracts, with broad application prospects and high industrialization value in pharmaceuticals, cosmetics, functional foods, health products, and other fields.

In terms of physical and chemical characteristics, its diverse appearance, clear physical and chemical parameters, good stability, and dual solubility (water-soluble and lipophilic) provide a fundamental guarantee for multi-dosage form R&D and multi-field application. In terms of functional features, it has multiple functions such as antioxidant and anti-aging, anti-inflammatory and soothing, metabolic regulation, antibacterial protection, and moisturizing and repairing, each supported by precise experimental data and scientific mechanisms of action, with clear, mild, and efficient efficacy. In terms of unique properties, its six advantages—three-dimensional synergy of active ingredients, mild and non-irritating, cross-field adaptability of medicine-food homology， outstanding metabolic regulation function, standardized controllability, and combination of tradition and modernity—enable it to stand out in the market and become a core raw material in multiple fields.

With the popularization of green consumption concepts, the upgrading of natural raw material technology, and the rapid development of the medicine-food homology industry, the standardized production process of purslane extract will be further optimized (such as the industrialization of deep eutectic solvent extraction technology), its functional mechanisms will be further clarified, and its application fields will be further expanded (such as the in-depth development of high-end pharmaceutical preparations, oral beauty products, and natural preservatives). In the future, relying on its unique advantages of "safety, efficiency, multi-functionality, controllability, and medicine-food homology ", purslane extract will occupy a more important position in the natural raw material market, provide better natural solutions for human health and beauty undertakings, and promote the high-quality development of the medicine-food homology plant extract industry.