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Herbal Sunscreen Review: Safe, Natural & Effective.

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Abstract:

Herbal sunscreens are an expanding category of skin care products that provide broad-spectrum photoprotection by combining plant extracts with UV-protective chemicals. Herbal formulations, in contrast to traditional chemical sunscreens, include plant-derived antioxidants, anti-inflammatory substances, and calming agents that offer extra skin advantages, including lowering oxidative stress, delaying photoaging, and enhancing skin barrier function. High SPF, broad-spectrum coverage, photostable formulas, non-comedogenic texture, and eco-friendly ingredients are all characteristics of ideal herbal sunscreens. Although phytochemicals and natural oils aid in photoprotection, mineral UV filters like titanium dioxide or zinc oxide are necessary for consistent SPF. Although there is still little in vivo confirmation, recent studies demonstrate the potential of polyphenols, flavonoids, and carotenoids to improve photoprotective performance. This paper provides a scientific foundation for creating efficient and skin-compatible herbal photoprotective products by outlining the optimal features of herbal sunscreens, their synergistic mechanisms, safety profiles, and eco-friendly considerations.

Keywords:

Herbal sunscreen

Broad-spectrum protection

Phytochemicals

SPF and photostability

Antioxidant skin protection

Introduction:

When fresh milk is left to stand, the high-fat part of the milk that rises to the top is called cream. It is either mechanically (centrifugal separation) or spontaneously (gravity separation) isolated from milk. Depending on its categorization (e.g., light cream, whipping cream, heavy cream), cream usually includes 18–40% milk fat. Its rich texture and emulsifying qualities make it a popular ingredient in baking, cooking, and dairy processing.[1]

Cream (as a dairy product) is classified as an oil-in-water (O/W) emulsion.

- In cream, fat globules (oil phase) are dispersed throughout the continuous phase (water portion of milk).
- Although cream is richer in fat than milk, the external/continuous phase is still water, so it remains an oil-in-water emulsion rather than water-in-oil.

CLASSIFICATION OF CREAMS: [3-08]

All the skin creams can be classified on different bases:

1. According to function,

e. g. cleansing, foundation, massage, etc.

2. According to characteristic properties,

e. g. cold creams, vanishing creams, etc.

3. According to the nature or type of emulsion, based on the function

1. Make-up cream (o/w emulsion).

- Vanishing creams.
- Foundation creams.

1. Cleansing cream,
2. Cleansing milk,
3. Cleansing lotion (w/o emulsion)

4. Winter cream (w/o emulsion)

a) Cold cream or moisturising creams.

4. All-purpose cream and general creams

5. Night cream and massage creams

6. Skin protective cream.

7. Hand and body creams.

8. Sunscreen.

1. **Make-up cream-**

These are mainly an o/w type of emulsion. It is a cream-based product that leaves a smooth, hydrated finish (either stain-matte or luminous) on the skin. It nourishes skin and is basically sweat-resistant, and creates a dewy sheen.

2. **Vanishing creams**:

They are called vanishing creams because they seem to disappear when rubbed onto the skin. These formulations are based on stearic acid. After application, the cream leaves a dry but tacky residual film, which also has a drying effect on the skin. Because of this, these are used particularly in hot climates, where they cause perspiration on the skin.

3. **Foundation creams**:

These creams serve as a foundation for makeup. It acts as an adherent base for the application of make-up powders. They provide emollient action and a protective action against the environment to the skin, which is neither too greasy nor too dry. It is multi-coloured make-up applied on the face to create an even, uniform colour similar to the complexion, to cover flaws and to change the skin tones.

4. **Cleansing creams.** These creams are used for body cleaning purposes, and it is used for personal hygiene and beautification, which is important for cosmetics. Cleansing creams or lotions can be used for the removal of make-up, surface grim, and oil, mainly from the face and neck

5. **Winter creams.** These are w/o a type of formulation, and in this formulation oil content will be more than the water content. These creams are mainly used for chapped and dry skin.

- **Cold cream**: It is known as a moisturiser or moisturising cream. Cold cream must have an emollient action. It should produce a cooling sensation in use, and the oil film on the skin should be non-occlusive.

6. **All-purpose creams and general creams**:

These creams are used more nowadays than before. These creams are an oily but non-greasy type and can be spread on the skin easily. This can also be used as a night cream, nourishing cream, or protective cream for the prevention or alleviation of sunburns or the treatment of roughened skin areas.

7. **Night cream or massage creams**: These creams are mainly used for nourishing the skin or as a treatment for dry skin. Creams that are generally applied on the skin and left for a few or several hours overnight are mainly known as night creams. Creams that act as an emollient by rubbing the cream on the skin with massage are known as massage creams.

8. **Skin protective creams**: These creams are smooth, thick-bodied creams formulated to provide an invisible, uniform protective film barrier to the skin. It helps to maintain the barrier between the skin and contaminants that may irritate the skin (contact dermatitis and occupational dermatitis). Strengthens the natural properties of the skin and maintains the balance of normal to combination skin.

9. **Hand and body creams**: Hands are one of the first places to show signs of ageing. We tend to wash our hands several times a day, stripping off moisture. Applying cream softens and protects the skin, and it keeps the skin looking younger. Since the skin on our palms and fingers needs oil to stay supple and to prevent it from chapping and cracking, it is sensible to use hand creams that put plenty of oil back in. It is used on the hands more than on other parts of the body.

10. **Herbal sunscreen:** It is a sun-protective formulation that uses plant-derived (herbal) ingredients either as the primary active UV-protective agents or as supportive components to enhance skin protection.

These formulas often contain botanical extracts with properties such as:

- **UV absorption** (e.g., green tea polyphenols, aloe vera, turmeric)
- **Antioxidant activity** (e.g., grape seed, liquorice, rosemary)
- **Anti-inflammatory or soothing effects** (e.g., chamomile, calendula)
- **Moisturizing** (e.g., coconut oil, shea butter)

❑ **Effective Sun Protection (High SPF & Broad-Spectrum)** [35]

- A good herbal sunscreen should provide **measurable SPF**, ideally via in vitro or in vivo testing, rather than just relying on claims. For example, in one formulation study using *Elaeagnus angustifolia* extract and fixed oils, the SPF ranged from ~6.4 to ~21 (depending on extract concentration).
- Broad-spectrum coverage (UVA + UVB) is important; many plant extracts absorb in UV-A and UV-B regions. In the same study, the purified extract showed constant absorption in ~290–370 nm range.
- Research shows herbal extracts like polyphenols and flavonoids can absorb UV and also neutralize free radicals produced by UV exposure.

❑ **Use of Photoprotective Phytochemicals (Antioxidants, Flavonoids, Polyphenols)** [36]

- Ideal herbal sunscreens should include **bioactive plant compounds** that offer antioxidant and anti-inflammatory effects. For example, in a review, phytochemicals such as polyphenols, carotenoids, flavonoids, and vitamins from plants were highlighted for their ability to scavenge free radicals and protect from UV damage.
- These phytochemicals not only protect by direct UV absorption but also by **minimising oxidative stress**, which helps prevent photoaging and cellular damage.

❑ **Stable and Safe Formulation** [37]

- Photostability: The herbal sunscreen needs to remain stable under exposure to heat and light. In a study of *Elaeagnus angustifolia* sunscreen formulations, a 6% extract formulation remained stable at 40 °C and 4 °C for 8 weeks.
- pH: The formulation's pH should be skin-friendly. In that same study, the pH of different formulations was in a reasonable range.

- Safety/Toxicity: The herbal extracts used should be non-irritant. In a formulation study, extracts were screened for phytochemicals and then tested for SPF and physicochemical parameters.

❑ **Synergistic Use of UV-Blocking Ingredients.** [35]

- While herbal extracts contribute, **UV filters (especially mineral) are often required** to reach good SPF. Though many herbal sunscreens are "herbal," they often pair botanicals with safe filters to boost protection.
- This synergy helps in building a broad-spectrum, effective sunscreen without relying solely on synthetic chemicals.

❑ **Low Irritation / Non-comedogenic.**[36]

- Because herbal sunscreens are often chosen for their gentleness, the formulation should minimize skin irritation. Using anti-inflammatory herbs (e.g., aloe, flavonoid-rich extracts) helps.
- For example, when creating herbal sunscreen creams, researchers have used plants like *Glycyrrhiza glabra* (licorice), *Tinospora cordifolia*, etc., for their anti-inflammatory, antioxidant, and wound-healing properties.

❑ **Good Cosmetic Properties (Texture, Spreadability, No Heavy Residue)** [37]

- A practical sunscreen should spread well on skin, have acceptable viscosity, and not feel overly greasy. In the *Elaeagnus angustifolia* study, the authors noted that adding extract did not significantly worsen spreadability, and in fact, formulations "seemed to be less greasy."
- The pH, viscosity, and consistency are important for making an herbal sunscreen user-friendly.

❑ **Photoprotective Herbal Oils or Extracts with UV Absorption**[37]

- Certain oils and extracts do absorb UV to some extent. In an in vitro study, herbal oils (fixed and volatile) were tested for UV absorption: SPF of non-volatile oils was found between ~2 and ~8; olive oil showed the highest among the tested fixed oils.
- These herbal oils can boost the UV-absorbing capacity of the formulation, though they alone are not enough for high SPF.

❑ **Eco-friendly and Biocompatible Ingredients**[36]

- The use of plant-based, biodegradable, and non-toxic ingredients is often part of what makes a sunscreen "herbal."
- According to a more recent multi-disciplinary review, herbal ingredient-based sunscreens may align with environmental sustainability because plant-derived components can be renewable and biodegradable.

- Also, avoiding harmful UV filters (like certain synthetic ones) can reduce environmental damage (e.g., reef harm), though this depends on the exact formula.

❑ **Validated by In Vitro & In Vivo Testing[34]**

- A good herbal sunscreen should not be just "natural" but **scientifically validated** for its SPF, photostability, and safety.
- For example, researchers measure SPF using spectrophotometric in vitro methods (wavelength scan) and evaluate physical stability (viscosity, phase separation) and extract activity.
- Clinical or in vivo testing (if available) adds robustness, though many published studies are in vitro.

❑ **Long-Term Skin Benefit[35,36]**

- Beyond UV protection, ideal herbal sunscreens should support skin health via antioxidant, anti-inflammatory ingredients that help prevent photoaging, pigmentation, and oxidative damage.
- Many studies explicitly include herbs with "wound healing, anti-inflammatory, antioxidant" properties (e.g., curcumin, quercetin, resveratrol) to provide multifunctional benefits in the sunscreen.

STRUCTURE OF SKIN: [4-7]

❖ The skin consists of the following layers.

a) Epidermis
b) Dermal epidermal junction
c) Epidermal appendages
d) Dermis
e) Subcutaneous fat

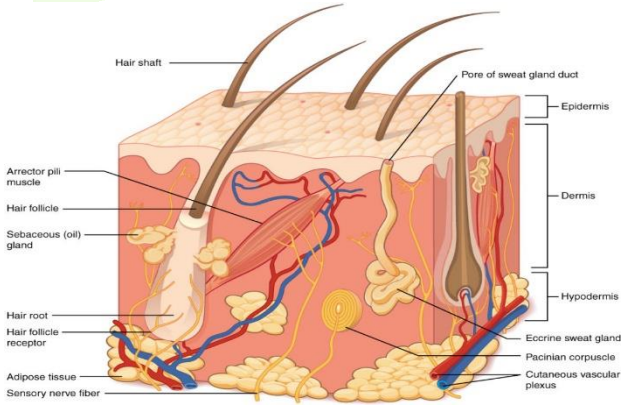

Fig. no.01Layers of the Skin

b) Epidermis:

The epidermis is a stratified, squamous epithelium layer, and it contains two types of cells, keratinocytes and dendritic cells. The main cell of the epidermis is the keratinocytes, which make up 95% of the total cells present in the epidermis. The thickness of the epidermis varies from 0.05

mm to 0 8-1. 5mm. The epidermis is further divided into four distinct layers according to keratinocytes, morphology and position. [1]

c) **Dermal epidermal junction.**

The dermal epidermal junction represents the acellular zone present between the dermis and epidermis. It supports the epidermis, establishes cell polarity, direction of growth and directs the organisation of the cytoskeleton in the basal cells, and it provides developmental signals and functions as a semipermeable barrier between layers.

d) **Epidermal appendages:**

The skin adnexa are a group of ectodermally derived appendages, including eccrine, apocrine glands, ducts and pilosebaceous units that originate as downgrowths from the epidermis during development. After injury, the adnexal structure is capable of re-epithelialization.

a) **Eccrine sweat gland**: Eccrine glands are distributed on the surface of the body. The principal function is heat control.

b) **Apocrine Gland**. They are 10times larger than an acrine gland, which secretes a milky substance.

c) **Sebaceous Gland:** It secretes sebum, which constitutes most of the fatty layer

d) **Hair**: Hair has valuable biological functions like protection from the elements and the distribution of sweat gland products.

e) **Dermis:** It is a system of fibrous filamentous, amorphous connective tissue. The dermis provides pliability, elasticity, and tensile strength to skin. It protects the body from mechanical injury, binds water, and provides thermoregulation and sensory stimulation.

f) **Subcutaneous fat**. Subcutaneous is an elastic layer that includes a large amount of fat cells that work as a shock absorber for blood vessels and nerve endings. The thickness of this layer is 4 to 9 mm on average.

❑ **FUNCTIONS OF SKIN**:[6]

- Protection
- Thermoregulation
- Heat Production
- Heat Loss
- Control of body temperature
- Activity of sweat glands
- Regulation of blood flow through the skin
- Formation of vitamin D
- Cutaneous sensation
- Absorption
- Excretion

Material and methods:

List of ingredients used in the herbal sunscreen: [8,9]

Herbal Ingredient	Function
Aloe vera	Soothing, mild UV absorption
Green tea extract	Antioxidant reduces UV-induced damage.
Turmeric (Curcumin)	Anti-inflammatory, antioxidant
Licorice extract	Reduces pigmentation from sun exposure
Carrot seed oil	Mild natural SPF (not enough alone)
Cucumber extract	Cooling, hydrating

1] Aloe vera: [9-13]

Rank	Classification
Kingdom	Plantae
Sub-kingdom	Tracheobionta (Vascular plants)
Superdivision	Spermatophyta (Seed plants)
Division	Magnoliophyta (Angiosperms)
Class	Liliopsida (Monocotyledons)
Subclass	Liliidae
Order	Asparagales
Family	Asphodelaceae (formerly Liliaceae / Aloaceae)
Subfamily	Asphodeloideae
Genus	*Aloe*
Species	*Aloe vera* (L.) Burm. f.
Synonyms	*Aloe barbadensis* Mill., *Aloe indica* Royle

Fig no 02 Aloe vera

Chemical constituents:

Primary immunomodulatory polysaccharide Acemannan (β-(1,4)-acetylated mannan), Glucomannans, Pectins, Hemicellulose, Gluco-oligosaccharides, Vitamin A (β-carotene), Vitamin C, Vitamin E, B vitamins B1, B2, B3, and B6, Choline, and Folic acid Vitamin B12, calcium, magnesium, zinc, selenium, potassium, sodium, manganese, copper, chromium, aloin A and B, aloe-emodin derivatives, anthranol, chrysophanol, isobarbaloin, and aloe-emodin Flavonoids (antioxidant), lignins (improve penetration), and saponins.

Uses:

- Wound Healing
- Anti-inflammatory & Skin Care
- Moisturizer
- Digestive Aid (Latex)
- Antimicrobial Activity

B] Green tea plant: [14-16]

Kingdom	Plantae
Clade	Angiosperms
Clade	Eudicots
Order	Ericales
Family	Theaceae
Genus	Camellia
Species	Camellia sinensis

Fig. No. 03 Green tea plant

Chemical constituents:

The significant antioxidant activity of green tea (Camellia sinensis) is attributed to its abundance of polyphenols, particularly catechins such as EGCG, EGC, ECG, and EC. Alkaloids that provide modest stimulation include coffee, theobromine, and theophylline. The umami flavour and soothing benefits of green tea are attributed to amino acids, particularly L-theanine. Additionally, the leaves provide vital minerals (potassium, magnesium, calcium, and manganese) and vitamins (C, B-complex, and K). Green tea's flavour, colour, and scent are also influenced by pigments, small lipids, and volatile aroma molecules.

Uses:

- Antioxidant activity
- Cardiovascular health.
- Weight management
- Cognitive effects
- Anti-cancer potential

C] Turmeric (Curcumin): [17-19]

Rank	Classification
Kingdom	Plantae
Clade	Angiosperms
Clade	Monocots
Order	Zingiberales
Family	Zingiberaceae (ginger family)
Genus	*Curcuma*
Species	*Curcuma longa*

Fig. no. 04 Turmeric (Curcumin)

Chemical constituents:

The primary bioactive components of turmeric (Curcuma longa) are curcuminoids, which include curcumin, demethoxycurcumin, and bisdemethoxycurcumin. These chemicals give turmeric its yellow hue and several pharmacological properties. Its scent and medicinal qualities are additionally enhanced by the presence of essential oils such as zingiberene, atlantone, and turmerone. Smaller levels of proteins and polysaccharides promote their functional and nutritional value. In addition to vitamins like vitamin C and B-complex, the rhizome provides minerals, including potassium, calcium, magnesium, and iron. Turmeric's anti-inflammatory and free radical-scavenging properties are further strengthened by phenolic acids and other antioxidants.

Uses:

- Anti-inflammatory
- Antioxidant
- Digestive health
- Antimicrobial and antiviral
- Potential anticancer properties
- Natural food coloring
- Skin care
- Hair care
- Dietary supplements
- Natural preservatives

D] Licorice: [20-24]

Rank	Classification
Kingdom	Plantae
Clade	Angiosperms
Clade	Eudicots
Order	Fabales
Family	Fabaceae (Legume family)
Genus	*Glycyrrhiza*
Main Species (used as liquorice)	*Glycyrrhiza glabra* (European/licorice)

Fig. no. 05 Licorice

Chemical constituents:

Triterpenoid saponins, particularly glycyrrhizin (glycyrrhizic acid), are abundant in licorice (Glycyrrhiza spp.) root and give it its distinctive sweetness.
Glycyrrhetic (glycyrrhetinic) acid, an aglycone with strong bioactivity, is also present.
Many of the flavonoids and isoflavonoids found in liquorice, such as glabridin, liquiritin, and isoliquiritigenin, have antioxidant properties.
It also contains polysaccharides made of sugars like glucose, arabinose, and rhamnose, as well as coumarins including liqcoumarin and umbelliferone.
Liquorice root's rich phytochemical profile is further enhanced by the presence of essential oils, tannins, amino acids, and mineral salts.

Uses

- Anti-Inflammatory
- Antiviral
- Antimicrobial
- Cough
- Sore Throat
- Bronchitis

E] Carrot seed:[25-26]

Rank	Classification
Kingdom	Plantae
Clade	Angiosperms
Clade	Eudicots
Clade	Asterids
Order	Apiales
Family	Apiaceae (Carrot or Parsley family)
Genus	*Daucus*
Species	*Daucus carota*
Subspecies (main for carrot seed oil)	*Daucus carota* subsp. *carota* (wild carrot)

Fig No 06 Carrot seed

Chemical constituents:

α-pinene (about 27%) and geranyl acetate (approximately 29%) are the two main monoterpene components of carrot seed essential oil.

Additionally, a substantial amount of oxygenated sesquiterpenes, such as 11αH-himachal-4-en-1β-ol (about 9.2%) based on GC-MS study, are present. A significant component of many carrot seed oil samples is carotol, a sesquiterpene alcohol that can make up as much as ~66.8% of certain wild or produced seed oils. Additional sesquiterpenes that contribute to the oil's complex fragrance character include daucene, (Z,Z)-α-farnesene, germacrene D, and trans-α-bergamotene. Petroselinic acid (~59.35%), linoleic acid (~11.82%), palmitic acid (~10.01%), and stearic acid (~2.41%) are among the important fatty acids found in the fixed (edible) oil of carrot seeds, in addition to volatile terpenes.

Uses:

- Anti-inflammatory
- antioxidant
- hepatoprotective
- digestive health
- diuretic
- menstrual-regulating

F] Cucumber: [27-29]

Domain	Eukaryota
Kingdom	Plantae
Clade	Angiosperms
Clade	Eudicots
Order	Rosids
Family	Cucurbitales
Genus	*Cucumis*
Species	*Cucumis sativus*

Fig no 07 Cucumber

Chemical constiruents:

Over 95% of cucumber fruit is water, with trace quantities of proteins, lipids, and carbs as well as minerals like potassium and vitamins like C and B vitamins.

Significant amounts of flavonoids, such as vitexin, orientin, isovitexin, quercetin, apigenin, and kaempferol, are present.

Additionally, cucumber contains bitter triterpenes, particularly cucurbitacins (such as cucurbitacin B, C, and E), which are members of the family Cucurbitaceae.

Stigmasterol, campesterol, β-sitosterol, and cardiac glycosides are among the sterols/phytosterols found in the plant.

Palmitic acid (~ 23–27%), linoleic acid (≈ 22–26%), and linolenic acid (≈ 40–46%) are among the fatty acids found in cucumber seeds and fruit**.**

Uses:

- Hydration
- Digestive Support
- Mild Anti-Inflammatory
- Soothing
- Cooling
- Anti-Puffiness
- Pesticidal

Evaluation test: [30-34]

1. **Appearance and Colour**
   Check for uniformity, absence of phase separation, and natural colour consistency.
2. **Odour**
   Ensure herbal ingredients do not produce off-smells.
3. **pH Measurement**
   Ideal range for skin products: **5.0–7.0**.
4. **Viscosity Test**
   Using a Brookfield viscometer to assess spreadability and consistency.
5. **Spreadability Test**
   Measures the ease of application on the skin.
6. **Homogeneity Test**
   Observe under magnification to ensure even distribution of herbal extracts and UV filters.
7. **Particle Size (if using ZnO/TiO_2)**
   Determine nanoparticle vs. micronised particle safety.

2. Sun Protection Efficacy Tests

1. **SPF Determination (in vitro or in vivo)**
   - *In vitro*: UV spectrophotometric method (Mansur method).
   - *In vivo*: Human volunteer testing under standardized UV exposure.
2. **UVA Protection Factor (UVA-PF)**
   Using persistent pigment darkening (PPD) method.

3. **Boots Star Rating (UVA/UVB balance)**
   Determines broad-spectrum efficacy.

4. **Photostability Test**
   Assess the stability of herbal actives and UV blockers after UV exposure.

3. Stability Studies

1. **Accelerated Stability Test**
   Store at **40°C ± 2°C** and **75% RH** for several weeks.

2. **Thermal Cycling Test**
   Alternating between hot and cold conditions to check phase separation.

3. **Centrifugation Test**
   Determines emulsion stability against separation.

4. **Freeze–Thaw Stability**
   Test product robustness under extreme temperatures.

4. Safety & Dermatological Evaluation

1. **Skin Irritation / Patch Test**
   24- or 48-hour closed patch testing on volunteers.

2. **Sensitization Test**
   Check for allergic reactions, especially from herbal extracts.

3. **Microbial Load Test**
   Total aerobic count, yeast & mould count.

4. **Preservative Efficacy Test (PET)**
   Challenge test to ensure microbial safety over shelf-life.

5. Herbal-Specific Quality Tests

1. **Phytochemical Screening**
   Identify the presence of flavonoids, phenolics, tannins, alkaloids, etc.

2. **Antioxidant Activity (DPPH/ABTS methods)**
   Measures the free-radical scavenging potential of herbal extracts.

3. **Quantification of Active Markers**
   e.g., quercetin, curcumin, catechins, depending on the herbs used.

Summary:

Herbal sunscreens combine plant-based extracts with mineral UV filters to protect skin from UVA and UVB radiation. Key features include:

- **High SPF and broad-spectrum coverage**, validated by in vitro and in vivo studies.
- **Phytochemical enrichment**, including antioxidants and anti-inflammatory agents such as polyphenols, flavonoids, green tea extract, liquorice root, and turmeric, which mitigate oxidative damage and photoaging.
- **Photostable and safe formulations**, ensuring consistent efficacy and minimal skin irritation.

- **Good cosmetic properties**, including non-greasy texture, easy spreadability, and minimal white cast.
- **Environmental safety**, with biodegradable and reef-friendly ingredients.

Herbal sunscreens are not only photoprotective but also support skin health, offering multifunctional benefits beyond UV protection. While plant extracts alone cannot achieve high SPF, their synergy with mineral filters provides reliable photoprotection and additional antioxidant support.

Conclusion:

Herbal sunscreens offer a promising alternative to conventional chemical formulations by integrating plant-derived antioxidants and soothing agents with mineral UV filters. The ideal herbal sunscreen should provide high SPF, broad-spectrum protection, photostability, skin compatibility, and environmental safety. Research supports the efficacy of phytochemicals in enhancing UV protection and mitigating photoaging, although standardization and in vivo validation are essential. Overall, herbal sunscreens represent a scientifically supported approach for safe, effective, and multifunctional skin photoprotection, aligning with both consumer demand for natural products and eco-friendly considerations.

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