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Review Article

A Systematic: Review on Herbal Sunscreen for Sun Protection

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Sunlight contains harmful radiations that can damage the skin. Ultraviolet (UV) radiation is classified into three types—UVA, UVB, and UVC. This review provides a detailed overview of the different types of ultraviolet radiation and their effects on the skin. To protect the skin from UV radiation, sunscreen formulations are used, which work by either absorbing, scattering, or reflecting the rays. The adverse effects of UV exposure, such as photo aging, skin cancer, and DNA damage, are discussed. This paper also highlights various types of sunscreen formulations and the agents used in them. Sunscreen agents are mainly divided into two categories: physical and chemical. Physical agents act by blocking sunlight, whereas chemical agents absorb it. The Sun Protection Factor (SPF) is used to determine the efficacy of sunscreen formulations. The method and equation for SPF calculation are described in detail, with ultraviolet spectroscopic techniques employed for in vitro analysis. The proposed method is simple, quick, and effective for determining SPF values. Herbal sunscreen formulations are preferred over chemical ones due to their minimal side effects. Several herbal sunscreen agents and their protective activities are also discussed.

Keywords: UV radiation, Sunscreen agents, Sun Protection Factor, Herbal sunscreens.

INTRODUCTION

Studies have revealed that skin cancer is the most commonly diagnosed cancer in the United States, with more cases reported each year than all other cancers combined. It is estimated that one in every five Americans will develop skin cancer before the age of 70. Nearly 8 billion dollars are spent annually on skin cancer treatment. Between 1994 and 2014, the number of individuals treated for skin cancer increased by an alarming 77%**.** Furthermore, around 90% of non-melanoma skin cancers are caused by exposure to ultraviolet (UV) radiation, and tragically, one person dies every hour from sun-induced skin cancer. Over the past two decades, significant progress has been made in understanding the clinical and biological effects of UV radiation. These include conditions such as photo-immunosuppression, erythema (skin redness), delayed tanning, photo carcinogenesis, and photo aging**.**

The present study focuses on the following aspects: -

- Types of ultraviolet (UV) radiation
- Harmful effects of UV radiation
- The need for sunscreen protection
- Currently available sunscreen agents
- Calculation of Sun Protection Factor (SPF)
- Herbal sunscreen formulations
- Overview of currently marketed sunscreen products

Skin: -

The human skin is the largest organ of the body, serving as a protective barrier that regulates heat and water loss while preventing the entry of harmful microorganisms and chemicals. Covering approximately **1.7 m²** of the body surface, the skin allows drugs applied topically to act both locally and systemically. It functions as a physical barrier through which drug transport mainly occurs via pores in the skin tissue. Although certain drugs

may show promising in vitro results, they should be carefully evaluated to avoid possible immunological alterations.

Structure of Skin: -

Human skin, the main route for transdermal drug delivery, is a complex organ made up of four primary layers:

1. Subcutaneous fat layer (Hypodermis)
2. Dermis (Overlying layer)
3. Viable epidermis
4. Stratum corneum (Non-viable epidermis)

Each layer plays a crucial role in protection, thermoregulation, and the absorption of external agents.

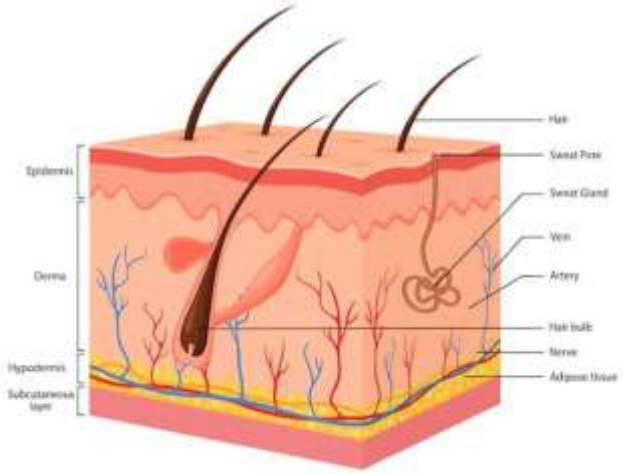

Fig. structure of skin

Effects of Ultraviolet (Uv) Radiation on Skin: -

Sunlight consists of a spectrum of wavelengths ranging from ultraviolet (UV) to visible light. UV radiation is divided into three types:

- UVA (320–400 nm)
- UVB (290–320 nm)
- UVC (100–290 nm)

Various Effects of Uv Radiation on Human Skin: -

1. Photoaging

The skin aging is multifactorial process classified as:

- Intrinsic aging**,** caused by genetic and biological factors
- Extrinsic aging**,** resulting from environmental exposure, mainly UV radiation.

2. Skin Cancer

Continuous, unprotected exposure to UV radiation is a major cause of skin cancer, which exists in two main forms:

- Melanoma skin Cancer

The most aggressive type, often linked to UV exposure**,** sunburns**,** genetic factors**,** and immune system deficiencies.

- Non-Melanoma Skin Cancer

Less deadly than melanoma but can still spread if untreated. The two major types are:

- Basal Cell Carcinoma (BCC):

Slow-growing, rarely metastasizes, but may invade deeper tissues and bones. It often appears as small, flesh-colored nodules on the head or neck.

- Squamous Cell Carcinoma (SCC):

Appears as red, scaly patches or nodules that can enlarge and metastasize if not managed promptly.

Sunscreen: -

Excessive exposure to ultraviolet (UV) radiation from sunlight can cause serious damage to the skin. To counter these harmful effects, sunscreen formulations are used. The primary function of sunscreen is to protect the skin from the damaging influence of solar UV radiation. The active ingredients in sunscreen act by absorbing, reflecting, or scattering UV rays before they can penetrate the skin, thereby preventing harm to underlying skin cells. Sunscreen functions much like an umbrella, shielding the skin from sunlight just as an umbrella protects from rain.

Sunscreening Agents: -

Sunscreening agents are broadly categorized into two types based on their mode of action:

1. Physical (Inorganic) Sunscreens
2. Chemical (Organic) Sunscreens

1. Physical Sunscreens: -

Physical or non-chemical sunscreens act by blocking, scattering, or reflecting UV radiation before it reaches the skin. These agents are primarily inert minerals that remain on the surface of the skin and provide broad-spectrum protection.

- Titanium Dioxide (TIO_2): -

Titanium dioxide is an insoluble, mineral-based compound widely used as a physical UV filter in cosmetic formulations. TiO_2 is highly effective against both UVA and UVB radiation, offers broad-spectrum protection, and is chemically stable.

2. Chemical Sunscreens: -

Chemical sunscreens protect the skin by absorbing UV radiation. These compounds are typically aromatic molecules with conjugated carbonyl groups, which absorb high-energy UV rays and release them as lower-energy radiation (usually heat), thereby preventing skin damage.

Depending on their molecular structure, some chemical sunscreens absorb only UVB, while others provide broad-spectrum (UVA and UVB) protection.

A. UVB Absorbers: -

(a) Para-Aminobenzoic Acid (PABA): -

PABA was one of the first chemical sunscreen agents used. Its derivatives, such as octyl dimethyl PABA (padimate O), show good compatibility with cosmetic bases but may cause skin irritation in some users. Though PABA has low SPF efficiency, it is sometimes used in combination formulations to enhance UVB protection.

(b) Benzophenone-3 (Oxybenzone); -

As reported by Serpone et al. (2007), Benzophenone-3 absorbs UV radiation in the 280–340 nm range, primarily filtering UVB and partially UVA2 rays. It converts absorbed photon energy into heat, thus preventing photochemical damage to the skin.

B. UVA Absorbers: -

Common UVA absorbers include:

- Anthranilate
- Avobenzone
- Terephthalylidene dicamphor sulfonic acid
- Bis-ethylhexyloxyphenol methoxyphenyl triazine

These agents absorb radiation mainly in the 320–340 nm rang**e**. They are more effective when combined with UVB filters, offering enhanced photo-stability and broad-spectrum protection.

Key Herbal Ingredients and Their Roles: -

Herbal sunscreens utilize the natural therapeutic and protective properties of various plant-based ingredients. Each herbal component contributes uniquely to enhancing the overall effectiveness of the formulation:

- Aloe Vera **(***Aloe barbadensis Miller***):** Renowned for its soothing and moisturizing abilities, aloe vera contains polysaccharides that aid in skin regeneration and minimize inflammation caused by UV radiation. It also forms a protective layer that prevents moisture loss and keeps the skin hydrated.

- Turmeric (*Curcuma longa*)**:** Rich in curcumin, a potent antioxidant and anti-inflammatory compound, turmeric helps neutralize free radicals generated by UV rays. It protects against UV-induced DNA damage and helps reduce photoaging symptoms such as pigmentation, wrinkles, and fine lines.

- Cucumber **(***Cucumis sativus***):** Cucumber extract provides a cooling and refreshing effect on the skin. Packed with antioxidants like vitamin C and caffeic acid, it alleviates sunburn, minimizes swelling, and combats oxidative stress triggered by UV exposure.

- Green Tea Extract (*Camellia sinensis*): Green tea is abundant in polyphenols, particularly epigallocatechin gallate (EGCG), known for their strong antioxidant, anti-inflammatory, and anti-carcinogenic activities. These compounds help reduce UV-induced oxidative damage and support the skin's natural repair processes.

- Vitamin E **(**Tocopherol**):** As a fat-soluble antioxidant, vitamin E safeguards cell membranes from oxidative harm caused by UV radiation. It neutralizes free radicals, improves skin hydration.

Types Of Herbal Sunscreen Formulations: -

Herbal sunscreens are developed in various forms to cater to different skin types, climatic conditions, and user preferences:

1) Cream-Based Herbal Sunscreens: These are generally prepared as water-in-oil (W/O) or oil-in-water (O/W) emulsions. They provide intense hydration and nourishment, making them especially beneficial for individuals with dry or sensitive skin.

2) Gel-Based Herbal Sunscreens: Light in texture and non-greasy in nature, gel formulations absorb quickly into the skin. They are particularly suitable for oily and acne-prone skin, offering protection without clogging pores.

3) Powder Herbal Sunscreens: Ideal for users seeking a matte finish, these formulations work well for oily skin types. They can be conveniently applied over makeup and help control excess shine while providing UV protection.

4) Lip Balm Herbal Sunscreens: Designed to safeguard the delicate skin of the lips, these formulations prevent UV-induced dryness, cracking, and discoloration while maintaining softness and hydration.

5) Spray Herbal Sunscreens: These offer effortless and uniform application, making them convenient for quick reapplication throughout the day. They are particularly useful for covering large body areas such as arms, legs and the back.

Sun Protection Factor (SPF): -

The effectiveness of a sunscreen formulation is determined by its Sun Protection Factor **(**SPF**)**. SPF indicates the amount of UV energy required to cause minimal erythema **(**redness**)** on protected skin compared to unprotected skin SPF=Minimal erythema dose (MED) on protected sk inMinimal erythema dose (MED) on unprotected ski nSPF=Minimal erythema dose (MED) on unprotecte d skinMinimal erythema dose (MED) on protected s kinThe MED represents the smallest UV dose that produces visible redness on unprotected skin. A higher SPF value means better protection against UVB-induced damage.

$SPF=CF\times\sum^{320}(\lambda)\times I(\lambda)\times Abs(\lambda)$

Where: EE(λ): Erythemal effect spectrum. I(λ): Solar intensity spectrum

Abs(λ): Absorbance of the sunscreen CF: Correction factor (usually 10)

According to research, SPF 15 filters about 72%**,** SPF 30 blocks 90%**,** and SPF 50 blocks 97% of UVB rays, allowing only minimal radiation to reach the skin.

Table: Currently Available Herbal Sunscreen Products: -

Branded sunscreen products	Manufacturer	Herbal constituent
Tomato sun Cream SPF36 PA++	Skinfood Cosmetics	Tomato
Natural Sun SPF25	Aubrey Organics	Green Tea, Aloe vera
Power light intensive fairness moisturizer SPF 15	Garnier	Lemon, Long dan
SPF30 natural mineral sunscreen	John Masters	Shea butter, Jojoba
Aroma sun tanning gel SPF10	Declore	Roman chamomile, Geranium Jasmine, Saffron, Bearbery
Saffron and bearberry faimess cream	Jovees	Saffron, Bearbery
Body lotion	Cosmetic Bakery	Sunflower oil
Hydra Light moisture-infusing lotion	Paula's choice	Pomegranate, Oats, Cranberry
Bio-pro carrot protective cream SPF15	Biotique Botanical Herbal	Carrot oil
Even out face cream SPF20	Oriflamme Cosmetics Inc	Liquorice
Ant wrinkle Moisturizing lotion SPF30	S B Cosmetics Inc,	Emblica
Super Resist antioxidant concentrate serum	Paula Choice	Turmeric
Biovera SPF75	Biotique Botanical Herbal extracts	Aloe vera
Save face & body sunscreen	Arbonne cosmetics	Bitter Orange

Advantages of Herbal Sunscreens:

Herbal sunscreens offer multiple benefits compared to conventional synthetic formulations:

- Free from Harmful Chemicals: These sunscreens do not contain synthetic additives such as parabens, phthalates, or oxybenzone, reducing potential skin and environmental harm.
- Non-Toxic and Eco-Friendly: Being plant-based and biodegradable, herbal sunscreens break down naturally without causing pollution or ecological damage.
- Gentle on Skin**:** Natural ingredients are typically less irritating, making herbal sunscreens ideal for individuals with sensitive or allergy-prone skin.
- Enriched with Bioactive Compounds: The presence of antioxidants, vitamins, and anti-inflammatory agents in herbal ingredients provides added skincare benefits like anti-aging and skin rejuvenation.
- Sustainable and Environmentally Friendly: The use of renewable botanical sources and eco-conscious production methods promotes environmental sustainability and balance.

CONCLUSION: -

A recent study published in *JAMA* revealed that certain chemical sunscreen ingredients such as avobenzone, octocrylene, oxybenzone, and ecamsule can be absorbed into the bloodstream within an hour after topical application. These chemicals may potentially cause harmful effects. Therefore, herbal sunscreens are considered safer alternatives due to

their natural origin, minimal side effects, and additional antioxidant benefits.

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