

Herbal Sunscreen Lotions: Current Trends and Future Perspectives

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Abstract: *The extensive application of harsh synthetic chemicals and rising pollution levels have become significant problems in today's world, leading to a renewed interest in the natural benefits of herbal resources. This review focuses on various components of herbs that might be photoprotective. UV light is the primary cause of sunburn and significantly increases the risk of serious conditions. Sunscreen-like qualities can help harmful UV radiation. Compared to synthetic alternatives accessible, and generally have fewer side effects. Management of long-term conditions. The antioxidant-rich herbs that enhance photoprotection include polyphenols, flavonoids, carotenoids (like lycopene and β -carotene), and phenolic acids. These compounds reduce the generation of free radicals, and reduce UV induced damage. It summarizes the present in various herbal sources that provide and provides a various form of UV radiation and their detrimental consequences.*

Keywords: - Herbal sunscreen Photoprotection Ultraviolet radiation Natural antioxidants Skin protection

I. INTRODUCTION

Sunscreen contains chemicals that protects excessive UV radiation. In addition to damaging DNA and increasing the risk of conditions like melanoma, various forms of skin immune system, cancer, erythema, oedema, hyperpigmentation, and photoaging suppression, prolonged UV exposure can damage keratinocytes. UV radiation is known to participate in the development of cancer. The Earth's surface is exposed to two types of solar radiation Ultraviolet-visible (UV-VIS) and infrared (IR) waves (1). Electromagnetic waves typically have a wavelength range of 100 nm to 1 mm. UV radiation (200–400 nm) has the shortest wavelength of these, followed by visible light (400–740 nm) and infrared radiation (760–1,000,000 nm). About 10% of the sun's total radiation is made up of UV rays. These rays are further separated into three categories: UVA, UVB, and wavelength (320–400 nm) and lowest energy, while UVC has the shortest wavelength (100–280 nm) (2).

Sunscreen, sometimes referred to as sunblock or suntan lotion, is a topical photoprotective agent that helps prevent skin damage and lowers the risk of skin cancer by either absorbing or reflecting UV radiation. It's also essential for preventing sunburn. Sunscreens come in a wide variety of forms, including lotions, gels, sprays, foams, powders, and sticks. In particular, natural ingredients are used in herbal sunscreen formulations to protect skin from UV rays and reduce the risk of sunburn and other skin damage (3).



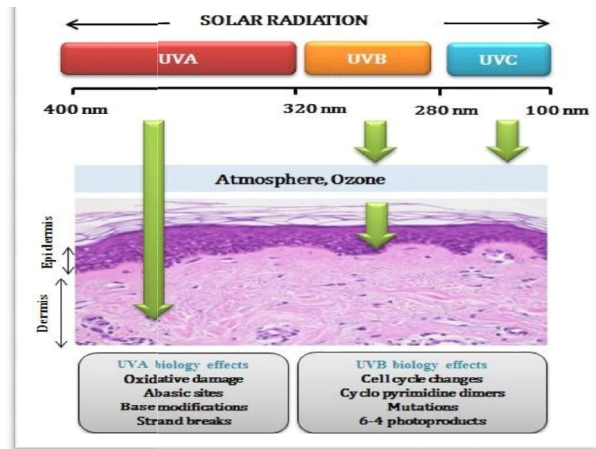


Fig. No. 1: Electromagnetic spectra solar ultraviolet (UV) rays and their biologic effects on the skin (4)

II. MEDICINAL PLANTS USED AS HERBAL SUNSCREEN

Tulsi (Sanctum Ocimum)

The purpose of Tulsi in sunscreen

- **Antioxidant advantages**
Two compounds in Tulsi that prevent UV-induced free radicals are flavonoids and eugenol.
- **Anti-inflammatory and calming qualities**
Sun can cause irritation and redness. Tulsi has calming and anti-inflammatory qualities. Perfect for delicate or sunburned skin (5).
- **The antibacterial qualities**
Because sunscreens can clog pores, Tulsi helps manage bacteria that can cause acne. helpful for skin that is prone to acne and oiliness.
- **Diminishes tanning and pigmentation**
Tulsi encourages skin repair, which may eventually reduce dark spots and tanning (6).



Fig no.2: Ocimum Sanctum: (Tulsi) (7)

Watermelon (Citrullus Lanatus)

Citrus Lanatus The melon that

Watermelon is a natural ingredient used in sunscreen to support skin protection and nourishment in addition to primary UV-filtering agents. It contains potent antioxidants like lycopene, vitamin C, and vitamin A that help created when skin is exposed to sunlight. These antioxidants help maintain the general health of the skin, lessen skin damage, and stop premature aging (8).



In addition to its protective qualities, watermelon's high-water content makes it incredibly hydrating. When combined with sunscreen, prevents dryness caused by extended sun exposure, leaving the skin feeling smooth, revitalized, and comfortable. It also has sun-induced redness or inflammation and soothe irritated skin. Because of this, it is particularly beneficial for sensitive or sun-exposed skin. Additionally, watermelon enhances the appearance of the skin and aids in skin repair, which may gradually reduce tanning and dullness (9).

However, watermelon does not offer SPF or directly shield the skin from harmful UV rays. Watermelon is a complementary ingredient that enhances the sunscreen's overall effectiveness and skin benefits, while specialized UV filters offer sun protection (10).

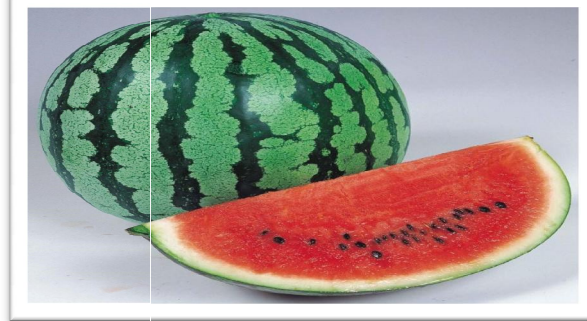


Fig no. 3: Citrullus Lanatus: (Watermelon) (11)

Turmeric (Curcuma Longa)

Turmeric is a common natural ingredient in sunscreen that, when combined with Filtering ingredients, enhances skin health and protection. It has curcumin, a crucial substance with potent antioxidant qualities that aids in scavenging UV-induced free radicals. This slows down the early signs of skin aging and lessens cell damage. In addition to its protective role, turmeric has potent anti-inflammatory qualities that help soothe skin and lessen sun-induced redness, irritation, and swelling (12). This makes it especially good for skin that is sensitive or exposed to the sun. Its antibacterial properties also aid in preventing skin issues like acne that can be brought on by perspiration and sunscreen accumulation. Additionally, turmeric helps improve skin tone and lessen pigmentation. It encourages the skin's progressively lessen uneven complexions, dark spots, and tanning (13). One of the reasons it is frequently utilized in both conventional and contemporary skincare treatments is its brightening qualities. Turmeric does not, however, directly shield the skin from damaging UV rays or offer SPF. Turmeric functions as a complementary ingredient that enhances the overall performance of the sunscreen by calming, protecting, and enhancing skin health, while specific chemical or mineral filters provide the actual sun-blocking effect (14).



Fig no. 4: Curcuma Longa (Turmeric) (15)



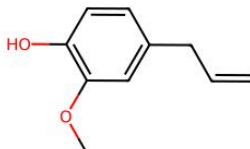
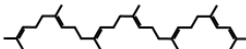
Pomegranate (Punica Granatum)

Pomegranate (*P. granatum*) juice has important antioxidant polyphenols, such as ellagitannins and anthocyanins. The effectiveness of three commercial sun protection products—Surround®, Parasol®, and Anti-stress-500® in preventing sunburn damage to pomegranate fruits cultivated (16). The degree of severe sunburn damage in the fruits was significantly reduced by using these sunscreen treatments, according to the results ($p = 0.05$) (17). In particular, fruits treated with Surround® (14.7%) and Parasol® (12.8%) showed a notable decrease in serious damage when compared to untreated control fruits (25.8%). However, applying Anti-stress-500® (19%) had no appreciable effect on reducing damage (18).

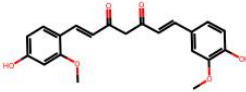
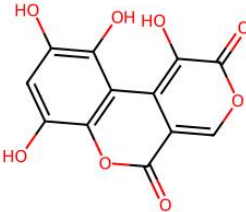


Fig no. 5: Punica Granatum (Pomogranate) (19)

Table No. 1: Active Ingredients and Structures Useful in Herbal Sunscreen

Herbal Source	Common Name	Active Ingredient	Chemical Structure	Role in Sunscreen
Ocimum sanctum	Tulsi	Eugenol		Antioxidant and anti-inflammatory activity
Citrullus lanatus	Watermelon	Lycopene		UV protection and free radical scavenging



Curcuma longa	Turmeric	Curcumin		Photoprotective and anti-aging activity
Punica granatum	Pomegranate	Ellagic acid		Prevents oxidative stress and photoaging

III. BENEFITS OF HERBAL SUNSCREEN OVER SYNTHETIC SUNSCREEN

Although synthetic sunscreens from the sun, some that they might be detrimental to skin health. Oxybenzone in their bodies gave birth to underweight baby girls. (20) Oxybenzone, one of the primary active components of chemical sunscreens, has been connected to these adverse effects. According to Australia's (TGA), common ingredients also produce free radicals when exposed to sunlight, which can damage healthy skin cells (21). Older sunscreen ingredients like PABA were replaced because of their risks, but even modern ingredients can cause skin irritation or discoloration. These concerns have increased demand for herbal sunscreens because they are believed to be safer and fewer side effects than chemical-based products (22). Pore clogging, allergies, and irritation are generally uncommon side effects of herbal formulations. Numerous naturally occurring plant-based accessibility, affordability, stability, safety, and purity. People have historically relied on plant extracts for skincare and cosmetic purposes, especially in rural areas, because the skin is constantly exposed to environmental factors (23). Due to their capacity to absorb ultraviolet (UV) radiation, natural materials have drawn interest as possible sunscreen agents in recent years. Furthermore, they have immunomodulatory, anti-inflammatory, and antioxidant qualities that contribute to the preservation and enhancement of skin health. (24) Herbal extracts are found in many commercially available sunscreens, but these components primarily serve as supportive agents rather than primary sun filters. (25)

Table No. 2: Herbal vs. Synthetic Sunscreens at a Glance

Feature	Herbal Sunscreens	Synthetic (Chemical) Sunscreens
Active Ingredients	Plant extracts (e.g., green tea, turmeric), fruit fats, and fixed botanical oils	Lab-created chemicals (e.g., avobenzene, oxybenzone, octocrylene)
How They Work	Absorb UV rays while simultaneously neutralizing free radicals with antioxidants	Absorb UV radiation and convert it into a tiny amount of harmless heat that dissipates from the skin
Skin Compatibility	Excellent for sensitive skin; plant bases are soothing and rarely cause allergic reactions or hormonal disruption	Can trigger reactions; some synthetic chemical filters cause contact dermatitis or redness in very reactive skin types



Texture & Finish	Usually thick and creamy; they leave no white cast but may feel heavy or greasy if not highly refined	Typically, thin and lightweight; easily blindable and leave a clear, invisible finish on all skin tones
Efficacy & Consistency	Variable; SPF ratings fluctuate based on batch and extraction, meaning they degrade rapidly under direct light	Highly precise; standardized formulas are strictly regulated to provide reliable SPF and lasting sun protection
Water Resistance	Low to moderate; naturally water-soluble so they require frequent reapplication (every 1–2 hours)	Often high; specific formulas are designed for extended, sweat-resistant, or water-resistant wear
Environmental Impact	Eco-friendly and sustainable; they are biodegradable and generally reef-safe	Environmental concerns; some synthetic ingredients have been linked to coral bleaching and water pollution

IV. EVALUATION PARAMETERS OF SUNSCREEN:

Sunscreens are topical treatments radiation. To ensure they are reliable, secure, and efficient, they go through a series of evaluation tests.

1. Sun protection factor, or SPF

SPF is the main indicator used sunscreen's effectiveness. It shows, which are the main cause of sunburn. It is calculated as the ratio of the minimum erythema dose (MED) of unprotected skin to that of protected skin. A higher SPF value indicates more protection (26,27).

2. UV Absorption Evaluation

A UV spectrophotometer is used to determine how much UV radiation the sunscreen absorbs between 200 and 400 nm. (28) It helps determine how well the product protects against UVA and UVB rays. The ideal sunscreen should provide broad-spectrum protection (29).

3. pH

Ideally be between 5.5 and 7, which is close to the skin's natural pH, to lessen the likelihood of irritation (30).

4. The Spreadability Test

The sunscreen covers the skin. Good spreadability guarantees even distribution, which is necessary for effective protection. It is dependent upon the formulation's consistency. (31,32)

5. Determining Viscosity

The thickness and flow characteristics of the sunscreen are revealed by viscosity, which is measured with a viscometer. An appropriate viscosity ensures that the product is stable and easy to use (33).

6. Water Resistance Testing

This test assesses the protective qualities water or perspiration. The product is applied, exposed to water, and then its SPF is measured once more in order to assess its effectiveness (34).



7. Stability Research

Stability testing involves exposing the sunscreen to a range of temperatures and humidity levels in order to monitor any changes over time. (35) Phase separation, color, odor, and pH are all monitored to ensure product stability during storage (36,37).

8. Skin Irritation Assessment

A patch test is used to determine whether the sunscreen is safe to use by looking for any adverse skin reactions, such as redness, itching, or inflammation (38).

9. Drug Content Uniformity

This test confirms that throughout the formulation. Spectrophotometric methods are typically employed in analysis (39,40).

10. In Vitro Diffusion Studies

The release of the formulation's active ingredients is this study. Diffusion cells are used in the process to help assess the product's efficacy and release rate (41,42).

11. Rheological Characteristics

The flow and deformation characteristics of the sunscreen are referred to as rheology. It affects the consistency, texture, and simplicity of applications, all of which have an impact on user acceptability (43,44).

V. DISCUSSION

Herbal sunscreens have become popular owing to growing fears about the detrimental effect that chemicals used in chemical sunscreens have on human health. Natural products manufactured through the use of plant extracts are characterized by the presence of active phytoconstituents such as flavonoids, polyphenols, carotenoids, anthocyanins, tannins, and phenolic acids, which are potent antioxidants and anti-inflammatories that help to reduce oxidative stress caused by ultraviolet radiation. Additionally, the use of plant products in sunscreens is helpful in protecting skin cells from photoaging, erythema, pigmentation, and damage. As already discussed, certain medicinal plants such as Tulsi, Turmeric, Watermelon, Pomegranate, Aloe vera, and Raspberry play an essential role in the manufacturing of herbal sunscreens. For example, the Tulsi plant is characterized by potent antioxidant, antimicrobial, and anti-inflammatory properties, whereas the turmeric plant is known for the presence of curcumin that is capable of protecting skin against irritation, inflammation, and discoloration triggered by UV rays. On the other hand, Watermelon is known for its moisturizing and antioxidant properties attributed to vitamins A, C, E, and lycopene, whereas the pomegranate fruit is known for polyphenols and ellagic acid. The use of herbal sunscreen is regarded relatively safe because it comes with fewer chances of adverse side effects such as skin irritation, reddening, allergic reactions, and toxicity. Apart from providing protection against damaging ultraviolet rays, the herbal sunscreens are also rich sources of antioxidants that help to protect the skin by ensuring its smoothness and elasticity. The ability to fight microbial infections and promote wound healing is another added advantage for herbal products.

VI. CONCLUSION

Excessive exposure to ultraviolet (UV) light causes the skin to various cell components. Despite the fact that synthetic organic used as photoprotective agents. becoming increasingly crucial to find safer alternatives to these synthetic goods. have gained popularity as natural sunprotective agents due to their numerous advantages for the skin and safety. Plant-based compounds are thought advantageous than chemical a and provide protection against oxidative stress, inflammation, and even cancer. based components can work well as preservatives and stabilizers in sunscreen recipes. Potent sun-protective properties. Developing a longlasting herbal sunscreen with strong SPF was the main objective of



this study. Among the tested formulations, values 33.50, strong antioxidant activity, and good stability. These herbal formulations were found to be safe be mutagenic. Additionally, the study discovered that UV spectroscopy is a reliable, efficient, and repeatable method for evaluating the efficacy of herbal sunscreens. Although chemical Sunscreen's as photoprotective agents, their use is gradually decreasing due to their adverse effects, which encourages the transition to safer, plant-based alternatives. These herbal formulations were found to be safe because they were not found to be mutagenic. Additionally, the study discovered that is a reliable, efficient. Although chemical sunscreens have long been used as photoprotective agents, their use is gradually decreasing adverse effects, which encourages the transition to safer, plant-based alternatives.

VII. FUTURE PROSPECT

Therefore, it can be boldly stated that there are many opportunities available for future advancement in herbal sunscreen preparations because of the increasing popularity of natural and safer cosmetic products. There will always be new findings about those plant species that offer better photo-protection, anti-oxidant activity, anti-inflammatory action, and skin nutrition. Moreover, novel strategies for preparing herbal sunscreens like nanotechnology, liposome preparation, use of nano emulsions, phytosomes, herbal gel formulations may have a great impact on the efficiency, skin permeability, SPF number, and general performance of herbal sunscreen formulations. In addition, clinical tests and safety profiles of long-term usage of herbal sunscreens should be performed. Also, standardization of herbal extracts, quality assessment of active components of plants, approval of concerned authorities with regard to use of herbal UV filters, optimization of herbal sunscreen formulation parameters are vital issues that should be considered. Finally, blending of herbal compounds and chemical sunscreens can be done to ensure maximum synergy, improved wide range UV radiation protection, and minimum adverse effects caused by synthetic sunscreen ingredients. In addition to this, increasing consumer awareness about the negative impacts of chemical substances used in sunscreen formulations on human beings as well as marine life is prompting scientists to develop environmentally friendly and bio-degradable sunscreen creams derived from herbs. The sustainable cultivation of medicinal herbs, sophisticated extraction processes, and the development of sustainable formulations can be considered important in helping produce effective herbal sunscreens on an industrial scale. Further research efforts in this direction should consider improvements in terms of formula stability, water repellence, shelf life, sensory attributes, and patient compliance as well.

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