

## Harnessing Herbal Ingredients for UV Protection: A Review of Natural Sunscreen Formulations

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### ABSTRACT

Exposure to ultraviolet (UV) radiation is a leading cause of premature skin aging, sunburn, and skin cancer. While conventional sunscreens provide protection, they often contain synthetic ingredients linked to photostability issues, allergic reactions, hormonal disruptions, and potential carcinogenic effects. These limitations have led to growing interest in herbal sunscreens, which offer safer, cost-effective, and eco-friendly alternatives. This review focuses on herbal ingredients with photoprotective properties and minimal side effects, emphasizing their potential in sunscreen formulations. Key herbal components such as shea butter, beeswax, rose water, olive oil, coconut oil, raspberry seed oil, grape seed oil, almond oil, rosehip seed oil, and tea tree oil are rich in flavonoids, phenolic compounds, and essential oils. These ingredients exhibit antioxidant, anti-inflammatory, moisturizing, and skin-rejuvenating properties, contributing to effective UV protection. The photostability of herbal sunscreens is also discussed, highlighting how certain natural compounds stabilize UV filters, ensuring sustained protection. Herbal sunscreens offer multiple advantages, including easy availability, renewable sourcing, low toxicity risks, and no requirement for specialized equipment during preparation. However, challenges such as formulation stability, standardization, and comprehensive clinical validation remain. Addressing these issues through further research could enhance the efficacy and safety profiles of herbal sunscreens. Overall, herbal sunscreens represent a promising, natural alternative to conventional formulations, offering broad-spectrum UV protection with reduced adverse effects.

**Keywords:** Herbal Sunscreen, UV Protection, Photostability, Antioxidant Activity, Flavonoids, Phenolic Compounds, Skin Care

### INTRODUCTION

UV protection is becoming very popular because of sunscreen's properties as a photo-protecting agent. Sunscreen preparation is applied topically, and its purpose is to heal, prevent or resist skin from painful or harmful effects of sunburn, suntan, sun cancer, and premature skin aging and to escalate the level of Sun Protection Factor (SPF). Sunscreens are a natural defense mechanism to defend against precarious UV radiation from the skin, which is the outer covering layer of the body. Its ability to absorb, reflect or scatter some of the sun's UV radiation on the skin from extravagant exposure to ultraviolet radiation. Skin melanoma, sunburn, photoaging, skin pigmentation, and various painful or precarious effects are caused by UVA and UVB rays. Antioxidant, wound healing, antifungal, premature aging, moisturizer, anti-inflammatory, and antiproliferative

activities are shown due to the key components of UV protection like flavonoids, phenolic compounds or herbal oils and also their UV rays absorption capacity in UV-A region. There are ample sunscreen formulations available in the market, which are used to protect skin from sunburn and skin cancer and during the market survey, it is found that there are some adverse effects like cell mutation, DNA damage, hormone alteration, and eczema (allergic reaction) by the synthetic sunscreen agents. Various formulations have multifunctional sun protection activity and it is based on their efficacy of UV rays absorption apart but most of the formulations are of high cost and merged synthetic molecules have toxicity and are even carcinogenic.

#### Advantages of Herbal Sunscreens:

- Easily available.
- No side effect.

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- No special equipment needed for preparation.
- Renewable resources.
- Botanical ingredients are easily available.
- They are inexpensive .

#### **Photostability and Toxicity:**

Photostability refers to a molecule's ability to remain stable when exposed to irradiation. This characteristic is particularly important for UV filters in sunscreen formulations, as they are specifically designed to absorb ultraviolet radiation (UVR). Photostability concerns have been notably raised for avobenzone, which has demonstrated photolysis, especially in *in vitro* systems that simultaneously irradiate and measure transmittance. This degradation can potentially affect the performance of other sunscreen agents within the same formulation. Similar photodegradation issues have been observed with octyl methoxycinnamate and octyl dimethyl PABA, while oxybenzone has been shown to exhibit relatively higher photostability. The need for higher SPF sunscreen products has led to the combination of multiple UV filters at maximum concentrations, increasing the potential for interactions that may impact overall photostability. The stability of these molecules is also influenced by the solvent or vehicle used in the formulation. Some ingredients, such as octocrylene, have been found to stabilize other compounds like avobenzone. However, the clinical relevance of these findings in *in vivo* conditions remains uncertain, and further research is necessary to fully understand these interactions.

#### **Potential Adverse Effects:**

Although sunscreens are effective in preventing sunburn, they may not necessarily reduce the risk of skin cancer. Moreover, certain ingredients in sunscreens can trigger mild to moderate allergic reactions in some individuals. Benzophenone also known as phenyl ketone, biphenyl ketone, or benzoylbenzene—is particularly noted for causing such reactions. While the extent of benzophenone absorption into the bloodstream remains unclear, trace amounts have been detected in urine after application. Continued research is essential to evaluate the long-term safety and systemic effects of these compounds.

#### **Photoprotection:**

Sunscreens, while effective, may offer insufficient protection against ultraviolet radiation (UVR) when used alone. They are most effective in preventing sunburn caused by UV-B radiation but provide

comparatively limited protection against UV-A radiation. Relying solely on sunscreens can inadvertently lead to prolonged outdoor exposure, especially among individuals who are prone to sunburn but develop poor tanning responses. Therefore, sun avoidance remains the most effective and recommended strategy for comprehensive sun protection.

#### **Sun Protection:**

Protecting the skin and eyes from the harmful effects of the sun is essential, as ultraviolet (UV) radiation accelerates skin aging and is the leading cause of skin cancer. Individuals with photosensitivity should take extra precautions. Additionally, sun protection is crucial at high altitudes throughout the year, especially in snowy conditions, as snow reflects additional UV radiation, increasing exposure to the skin.

#### **Herbal Ingredient Used for Sunscreen:**

##### **Shea Butter (*Vitellaria paradoxa*)**

It is obtained from the fat of the shea nut. The shea tree originates from the savannas of Africa. Its potential is to melt at body temperature and to absorb rapidly into the skin and it gives results without leaving a greasy feeling. It is used as an antioxidant and it contains vitamins like A and E, both of which enhance skin cell regeneration and circulate blood below the skin's surface. The oil contains Cinnamic acid and provides vital protection against precarious UV rays.



**Figure No.-01 Shea Butter**

##### **Bees wax (*Cera alba*)**

It is derived from honeybees of the genus *Apis* and it is a natural wax. Mainly Beeswax foundation is used as an emulsifier and thickener and can also be used for emulsion stabilization. Beeswax is used for melting the solids to facilitate the mixing with the water phase's ingredients by heating and mixing method. Its most important purpose is to compose a creamy texture.



**Figure No.-02 Beeswax**

**Rose Water (*Rosa damascena*)**

It is extracted from the rose by liquid-liquid extraction .One of the most important factors is that they have a good source of antioxidant activities and also be used for beautifying purposes for their sterling sunscreen . Gelatin and its hydrolysates procured from fish gelatin of tilapia (*Oreochromis niloticus*) were found to possess a scavenging effect against reactive oxygen species of UV that renders precarious effects to the skin. It is a novel source of components that have potential in skin anti-aging products and is also used as an emulsifying agent.



**Figure No.-03 Rose Water**

**Olive oil (*Olea europaea*)**

It is a fat derived from the olive fruit. Olive oil is made up of triglyceride esters of oleic acid and palmitic acid along with traces of squalene, sterols, (phytosterols, and tocosterols), and also consists of polyphenols like esters of Tyrosol and hydroxyl tyrosol including oleocanthal and oleuropein. Some flavonoids and lignans are also present. Olive oil has been World Journal of Biology Pharmacy and Health Sciences, 2023, 13(02), 029–040 32 used as a home remedy for skin care. Squalene is utilized as an antioxidant, and moisturizer, and in topical sunscreen preparation, it is a convenient vehicle to carry other substances.



**Figure No.-04 Olive oil**

**Coconut Oil (*Cocos nucifera*)**

It is a tropical plant that grows and is cultivated numerously by Indonesian people . It contains fatty acids and is reported to possess antioxidant properties photoprotection, and other medicinal activities like anti-bacterial, skin barrier repair, anti-aging, wound healing, and moisturizing in atopic dermatitis treatment.



**Figure No.-05 Coconut Oil**

**Raspberry Seed Oil (*Rubus idaeus* seed) (RSO)**

It is the fixed oil yielded from the seeds of the Raspberry and its components are fatty acids, and high concentrations of vitamins A and E, so appreciated in the cosmetics and pharmaceutical industries. Its potentials that are high antioxidant capacity and exhibited anti-inflammatory, anti-aging, anti-mutagenic, and antimicrobial properties and also used as an efficient moisturizer and emollient which aids to alleviate oxidative stress in the skin, is utilized in cosmetic emulsions for UV protection [12,13]. It assists to protect cells from oxidative damage and also aids with maintaining the structure of the collagen [13]. Use it to moisturize your face without blocking pores, so it is also non-comedogenic [15]. It has sun-protective qualities and is also rendered beneficial to people glancing for a mild, non-irritating moisturizer with a Sun Protection Factor (SPF).



**Figure No.-06 Raspberry Seed Oil**

**Grape Seed Oil (*Vitis vinifera*)**

It is the most important source of polyphenols (60%-70%). It has the property of antioxidants with strong antiinflammatory and antiproliferative activity. The polyphenolic phytoalexin namely resveratrol (trans-3,5,4'- trihydroxystilbene) is present in both the skin and seeds of grapes. It acts as an antioxidant with strong antiinflammatory and antiproliferative activity.



**Figure No.-07 Grape Seed Oil**

**Almond Oil**

It is the richest source of polyphenolic compounds especially flavonoids and phenolic acids. Its potential is that the property of UVB protection of this plant's skin extract and its topical application has significant antioxidant, skin brightening, and anti-photo aging properties.



**Figure No.-08 Almond Oil**

**Rosehip Seed Oil (*Rosa canina*)**

It is the richest source of vitamin C, carotenoids, polyphenols, and different flavonoids that show antioxidant properties. In addition, It has strong anti-inflammatory and antioxidant properties that

stimulate the synthesis and restoration of collagen. It has anti-aging properties and acts as a moisturizer.



**Figure No.-09 Rosehip Seed Oil**

**Tea Tree Oil (*Melaleuca alternifolia*)**

It acts as an effective antiseptic, fungicide, and germicide and it is a widely used ingredient of ample sunscreen formulations that relieve sunburn by increasing blood flow in capillaries, bringing nutrients to damaging skin.

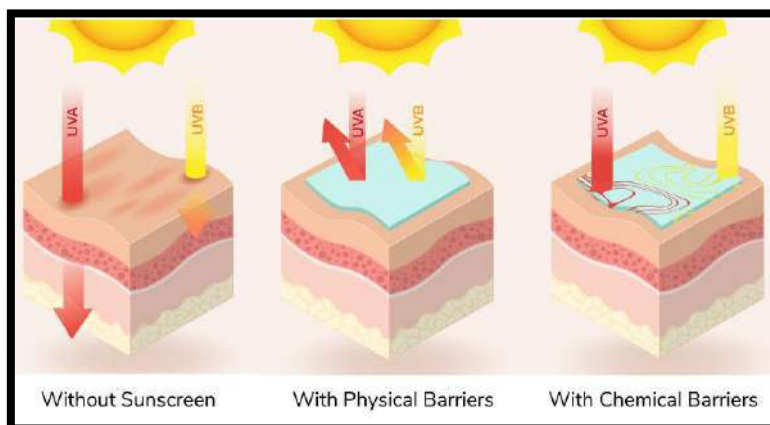


**Figure No.-10 Tea Tree Oil**

**Working of herbal Sunscreen:**

Herbal sunscreen formulations provide sun protection through multiple mechanisms, primarily by absorbing UV radiation, neutralizing free radicals, reducing inflammation, and enhancing skin hydration. Certain natural oils, such as raspberry seed oil and grape seed oil, contain flavonoids, polyphenols, and carotenoids that effectively absorb both UVA and UVB rays, acting as natural sunscreen agents. Additionally, antioxidants like Vitamin E, resveratrol, and squalene, present in oils such as olive oil and almond oil, help combat UV-induced oxidative stress, preventing DNA damage and premature aging. The anti-inflammatory properties of tea tree oil and shea butter help soothe sunburn and reduce skin redness, making them valuable additions to herbal sunscreen formulations. Moreover, moisturizing agents like beeswax and rose water strengthen the skin barrier, preventing UV-induced dehydration and enhancing overall skin protection. Some herbal ingredients, such as coconut oil and raspberry seed oil, also improve the photostability of sunscreen formulations, ensuring

prolonged effectiveness against sun exposure. Collectively, these natural components work synergistically to provide broad-spectrum sun protection while nourishing and repairing the skin.



**Figure No-11 Working of herbal Sunscreen**

### DISCUSSION:

The increasing concerns regarding the safety, toxicity, and photostability of synthetic sunscreens have fueled interest in herbal alternatives. Herbal sunscreens, enriched with natural compounds such as flavonoids, phenolic acids, and essential oils, not only provide effective UV protection but also offer additional therapeutic benefits such as antioxidant, anti-inflammatory, anti-aging, and moisturizing effects. Ingredients like shea butter, coconut oil, raspberry seed oil, and grape seed oil exhibit strong photoprotective properties, making them ideal candidates for natural sunscreen formulations. However, while herbal sunscreens hold significant promise, challenges such as formulation stability, variability in natural ingredient composition, and lack of standardized testing protocols need to be addressed. The photostability of herbal components, their interactions within formulations, and their effectiveness *in vivo* require further exploration. Additionally, extensive clinical trials are necessary to validate the efficacy and safety of these formulations compared to conventional sunscreens. The incorporation of nanotechnology and advanced formulation techniques could enhance the delivery and performance of herbal sunscreens, improving their commercial viability.

### CONCLUSION:

Herbal sunscreens represent a promising alternative to synthetic formulations, offering effective sun protection with minimal side effects. The natural ingredients reviewed in this paper exhibit strong antioxidant, anti-inflammatory, and UV-absorbing

properties, contributing to their effectiveness in preventing photoaging, sunburn, and skin cancer. Moreover, herbal sunscreens are cost-effective, environmentally friendly, and easily accessible. Despite these advantages, further research is essential to overcome existing challenges, particularly concerning photostability, formulation standardization, and clinical validation. Advances in formulation science and nanotechnology could significantly improve the performance of herbal sunscreens, ensuring broader adoption. In conclusion, herbal sunscreens provide a safer, sustainable, and efficient approach to sun protection, aligning with the growing demand for natural and holistic skincare solutions.

### RESULT:

The review highlights that herbal sunscreens formulated with natural ingredients such as shea butter, beeswax, rose water, olive oil, coconut oil, raspberry seed oil, grape seed oil, almond oil, rosehip seed oil, and tea tree oil exhibit significant photoprotective properties. These ingredients are rich in flavonoids, phenolic compounds, and vitamins (A, C, and E), which contribute to UV absorption, antioxidant activity, and anti-inflammatory effects. The analysis demonstrates that herbal formulations can effectively protect against harmful UVA and UVB radiation, reducing the risk of sunburn, photoaging, and skin cancer. Additionally, these herbal ingredients provide supplementary benefits such as moisturizing, wound healing, and skin barrier repair without the adverse effects

commonly associated with synthetic sunscreens, such as hormone disruption, DNA damage, and allergic reactions. Furthermore, herbal sunscreens show better patient compliance due to their non-greasy texture, pleasant aroma, and minimal irritation potential. Ingredients like octocrylene in synthetic sunscreens, known for photostabilizing avobenzone, can be replaced by natural oils that offer similar stabilization effects. The findings indicate that while herbal sunscreens are effective and safer alternatives, challenges related to formulation stability, photostability, and standardization remain. Nonetheless, combining herbal ingredients with advanced formulation techniques can enhance their efficacy and ensure sustained sun protection, meeting consumer demand for safer, eco-friendly skincare solutions.

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