



A systematic review: - The efficacy and safety of sunscreen use for the prevention of UV light

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Abstract

Ultraviolet (UV) radiation is the primary cause of various skin diseases, necessitating the need for UV protection. Topical sunscreens are the most commonly used method to achieve this. However, traditional sunscreen formulations have limitations that hinder their widespread use.

Evidence suggests that visible light and infrared light may play a role in photo aging and should be considered when choosing a sunscreen. Currently, there is a paucity of US FDA-approved filters that provide protection against long UVA (> 370 nm) and none against visible light. Additionally, various sunscreen additives such as antioxidants and photolyases have also been reported to protect against and possibly reverse signs of photoaging. This literature review evaluates the utility of sunscreen in protecting against photoaging and further explores the requirements for an ideal sunscreen. Developments in photo protection could lead to the creation of sunscreens with antioxidants that can neutralise reactive oxygen species (ROS) and stay on the skin's surface for extended periods of time. Antioxidants may enhance the photoshielding effect by squelching free radicals. Reviewing prospective herbal candidates with antioxidant qualities that can function as a potent barrier in cosmeceuticals to shield skin from damaging UVB rays, this paper concentrates on photoprotection from UVB radiation.

Keywords: Sunscreens, UV radiation, Sun protection factor (SPF), Cosmeceuticals

INTRODUCTION

The greatest satisfaction in life is health. "PEHLA SUKH NIROGY KAYA" is a proverb that states that happiness comes from having excellent health first. A sound nation should be constructed by sound residents. People's primary concern is their health, and for ages, many medical systems have been practiced worldwide with the shared goal of "Perfect Health for All."

Various types of traditional system include:-

1. Ayurveda
2. Siddha
3. Homeopathy
4. Unani

Importance of traditional system:

Artificial sunscreens are already gaining traction in order to protect the skin from sunburns, photoaging and photocarcinogenesis. However, the efficacy and safety of most artificial sunscreen constituents are hindered by their photostability, toxicity and damage to marine ecosystems. Natural selection and evolution have ensured that plants and animals have developed effective protective mechanisms against the deleterious side effects of oxidative stress and ultraviolet radiation (UV). Hence, natural antioxidants such as sun blockers are drawing considerable attention.

The sun has always been essential to life on the planet. It provides illumination, warmth, and energy. For carbon and water, every plant that supports life on Earth is dependent on the sun. Without the sun, life would be impossible. Nature provides a further sophisticated system of defense, making life possible. Two protective shields, or hollow spheres of gas enclosing the world, prevent the brief and most destructive solar radiations from reaching the earth's surface. [Armstrong BK, et al., 1993] The ionosphere is the outer layer, which reflects X-rays back into space [1, 2]. The ozone layer, on the inside, absorbs the shorter UV rays. Sunrise and sunset were among the first natural events to be seen and admired since the dawn of time. Sunrise signaled the arrival of light and was connected with positivity, brightness, and warmth. Sunset marked the end of the day and the beginning of the night, and it came to be connected with evil. Sunrise was later equated with life, while sunset was associated with death. Sun exposure and photo protection are likely to have played a role in evolution. Even if there had been no distinctions in skin type as we know them now, those with pale skin would have faced numerous obstacles in sunny regions, whilst those with darker skin types would have had a higher risk of vitamin D insufficiency if they lived in less sunny areas of the world. This may have resulted in paler skin types living farther away from the equator and darker skin types living closer to it. In such circumstances, photo protection by skin colour was more of a matter of survival [3, 4].

CLASSIFICATION OF UV RADIATION: - UV radiation is the part of electromagnetic radiation that is between visible light and x-rays, or between 200 and 400 nm in wavelength. There are three categories of this UV radiation based on wavelength [6].

Table No: 1. Ultra violet – classifications with their wavelength

UV – Classifications	Wavelength
UVA	320 – 400 nm
UVB	280 – 320 nm
UVC	200 - 280 nm

1. **UV-A Radiation:** This radiation ranges between 320 to 400 nm. UV-A is most responsible radiation for immediate tanning or darkening of the skin due to excess production of melanin in the epidermis, premature photo ageing, suppression of immunologic functions, and even necrosis of endothelial cells and damage of dermal blood vessels.
2. **UV-B Radiation:** This radiation ranges between 280 to 320 nm. UV-B radiations are known as burning rays as they are 1000 times more capable of causing sunburn than UV-A. UV-B rays act mainly on the epidermal basal cell layer of the skin but more genotoxic than UV-A radiations. Ultraviolet B (UVB) rays vary with time and season are major cause of sunburn. Sunburned skin is a leading risk factor for melanoma and non-melanoma skin cancer.
3. **UV-C Radiation:** This radiation ranges between 200 to 280 nm. UV-C radiations are filtered by stratospheric ozone layers so less effective and hazardous [5].

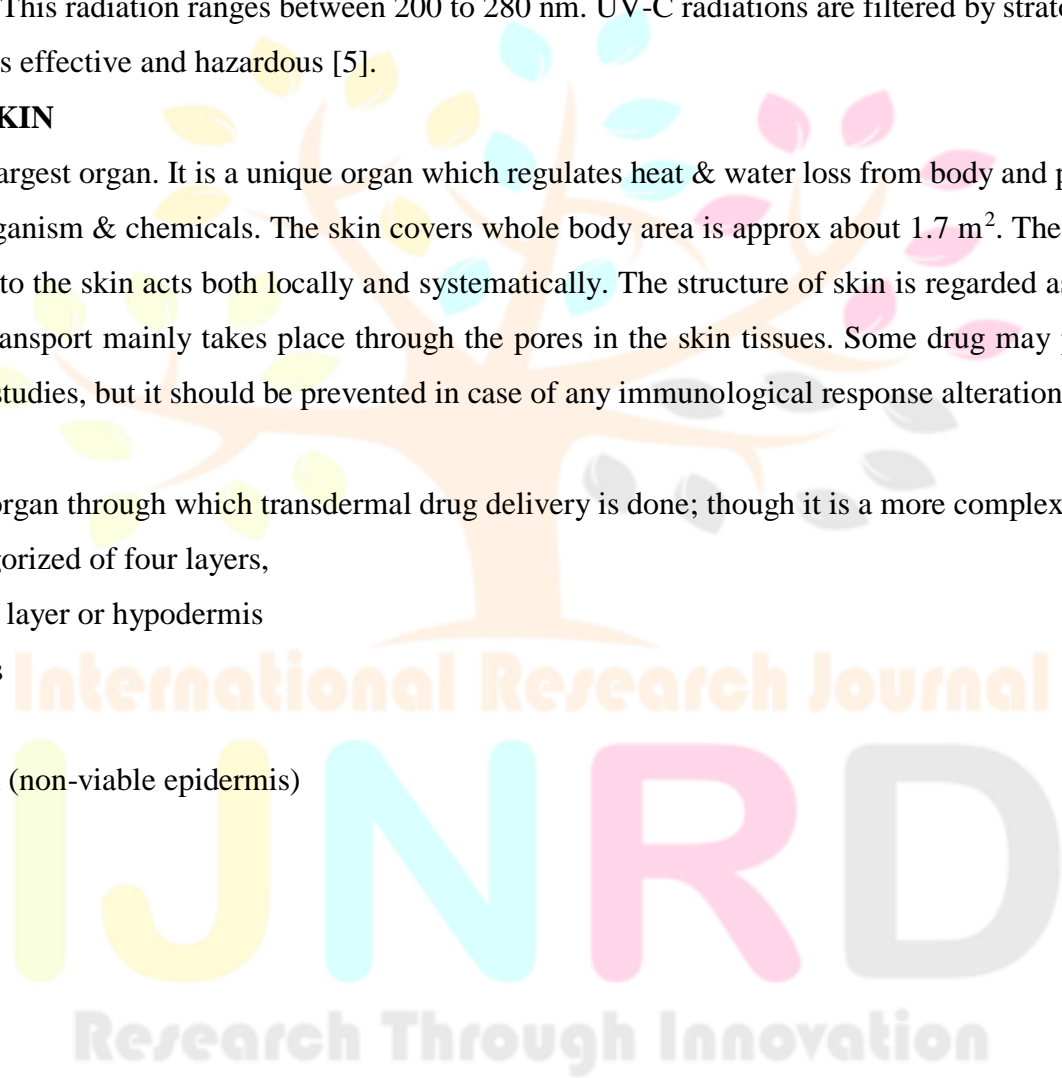
ANATOMY OF SKIN

Human skin is the largest organ. It is a unique organ which regulates heat & water loss from body and prevents the body from microorganism & chemicals. The skin covers whole body area is approx about 1.7 m². The therapeutic agent administered to the skin acts both locally and systematically. The structure of skin is regarded as a physical barrier. The drug transport mainly takes place through the pores in the skin tissues. Some drug may prove to be optimal in *in-vitro* studies, but it should be prevented in case of any immunological response alteration [5, 8].

Structure of skin:

Human skin is the organ through which transdermal drug delivery is done; though it is a more complex organ. The skin is mainly categorized of four layers,

1. Subcutaneous fat layer or hypodermis
2. Overlying dermis
3. Viable epidermis
4. Stratum corneum (non-viable epidermis)



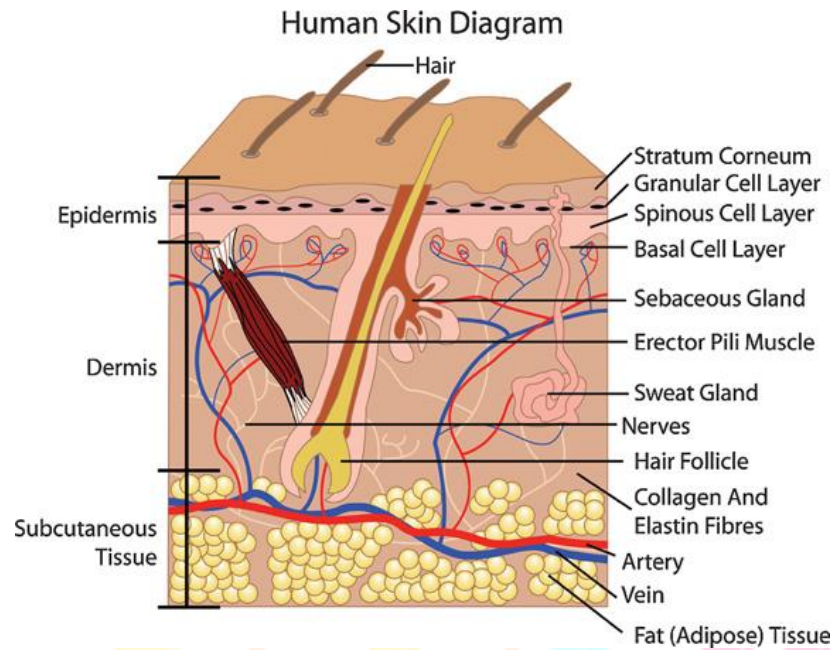


Figure 1. Structure of human skin. Copyright (2013) Allured Publishing, Reprinted with permission from R. Mc Mullen, Antioxidants and the Skin, Allured Books: Carol Stream, IL (2013).

THE VARIOUS EFFECTS OF UVR TO THE HUMAN SKIN

PHOTO AGING

The skin aging process is complex and of two types: intrinsic and extrinsic aging. The intrinsic is mainly caused due to the genetic factors. Extrinsic aging is caused mainly due to the external factors like UVB and cause wrinkling and degeneration of elasticity of skin [10, 11].

The UVB radiation exposure, by including the oxidative stress causes skin aging. It also leads to the production of extracellular matrix (ECM), and activates the nitrogen-activated protein kinase (MAPK) pathway. Thus, the UVB induced photo aging can be prevented by inhibition of MAPK pathway.

ERYTHEMA

Erythema (from the Greek erythros, meaning red) is the redness of the skin or mucous membranes caused by superficial capillary congestion (increased blood flow).

Short-wave ultraviolet (UV) radiation can cause sunburns, which are characterized by an immediate inflammatory response in the affected skin area, including erythema, edema, heat, itching, and pain. In the acute phase of the reaction to solar radiation, cutaneous erythema and immediate darkening of the pigment caused by UV rays occur at the same time, making it difficult to distinguish erythema and pigmentation by visual evaluation [7].

SKIN CANCER

UV radiation's unprotected exposure is the most harmful for skin cancer. Skin cancer can be developed by long term exposure to sun's UV radiation. Skin cancer is off two types: Melanoma skin cancer and non-melanoma skin cancer.

Melanoma skin cancer is the most serious form of skin cancer. UV exposure and sunburns are not only the cause for this type of skin cancer. It can also be caused due to other disorders including immune system deficiency and genetic factors [12].

Non-Melanoma skin cancer is not more deadly as melanoma, but it would spread if not treated and cause more serious health problem. The two main forms of non-melanoma skin cancer are basal cell carcinoma (BCC) and squamous cell carcinoma (SCC). BCC grows very slowly and rarely spread to other part of the body. It appears as small fleshy bumps or like nodules on the neck and heads. It also can penetrate into bones and cause damage. SCC appears as red scaly patches or like nodules. This type can be developed to large masses and spread to all part of the body.

Differentiations of skin cancer

Types	Description	Appearance	Occurrence
Basal cell carcinoma	Develops in the basal cells of the epidermis of the skin.	Non-fatal open ulcers, small pinkish growth.	The most widespread cancer.
Squamous cell carcinoma	It develops in squamous cells of skin.	Like warts Squamous plaques Feather ulcers	Occurrence less than Basal cells carcinoma
Melanoma	It develops in the cells of the skin is called a melanocyte.	Is multi-color, is asymmetrical, and the size can reach 6mm.	Cancer rarely occurs.

How should sunscreen be applied?

Observational studies have shown that consumers typically under apply sunscreen, with standard use ranging between 20% and 50% of the recommended application.^{30–32} However, using sunscreens with higher SPFs may compensate for under application.²⁶ For example, when a sunscreen with an SPF of 50 is applied under real-world conditions, the sunscreen may provide an SPF of only 25 [14].

A 2015 Canadian consensus meeting agreed that the wording “apply sunscreen generously” was most appropriate, given differences in body habitus of the public.³³ Figure 2 offers a rough estimate of the quantities of sunscreen that should be applied by a person of average height and build, based on advice from the Canadian Cancer Society and the American Academy of Dermatology.

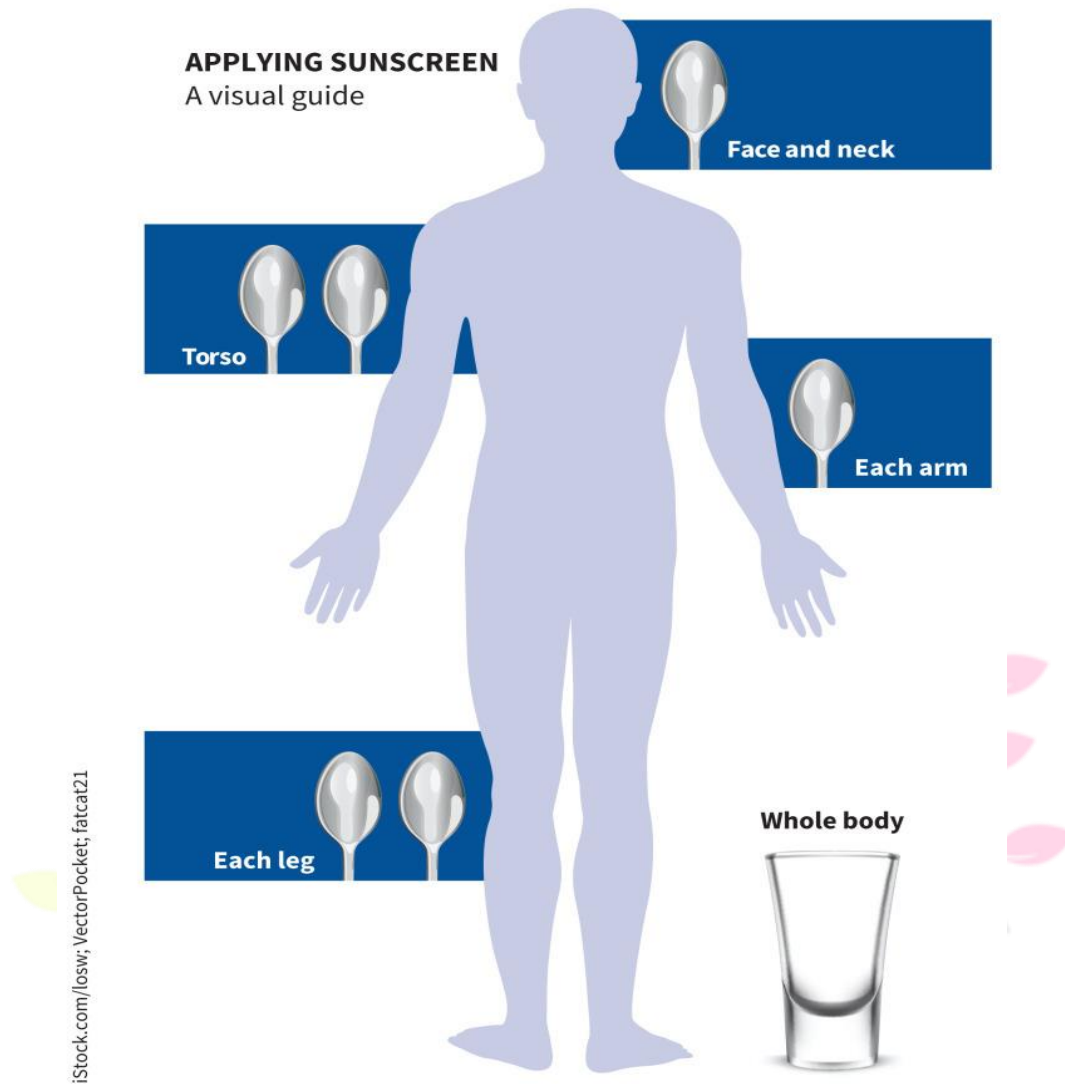


Fig.2. Visual aid to guide the correct application of sunscreen for a person of average height and body habitus, based on advice from the Canadian Cancer Society and the American Academy of Dermatology.

Physical barriers for UV protection

The use of sun protection clothing, sunglasses, hats, umbrellas, and physical barriers that prevent sun exposure are very common sun protection options. However, due to various social reasons, such as comfort, greater protection efficiency sunscreen is the most preferred and main method of sun protection [13].

Sun protective clothing - The UV Protection Factor of clothing depends on many factors, including fabric structure, type, color, weight, thickness, finishing process, and the presence of additives, such as substances that absorb ultraviolet light.

Sun protection clothing is generally evaluated according to the clothing index, which is actually an ultraviolet protection factor (UPF) as shown in table 1.4, that is, the ratio of the average effective ultraviolet radiation irradiance transmitted and calculated through the air and the irradiance average effective ultraviolet radiation transmitted and calculated through the fabric. UPF fabric is similar to SPF sunscreen, except that sunscreen fabric is used instead of sunscreen to protect skin during testing.

Table No: 2 Grade of clothes for ultraviolet protection factor.

Sr. no	Grade	UPF
1	Good protection	15 to 24
2	Very good protection	25 to 39
3	Excellent protection	40 to 50+

Sun protective sunglasses - Sun protection sunglasses are only a means of protecting delicate eyes from the harmful effects of solar radiation. Their protective effect is generally evaluated according to the amount of light that passes through the lens of the sunglasses, which is called light transmittance.

How do sunscreens work?

Sunscreens contain chemical (organic) or physical (inorganic) compounds that act to block ultraviolet radiation, which is light with wavelengths shorter than visible light (subdivided into ultraviolet A [UVA]1, UVA2, ultraviolet B [UVB] and ultraviolet C [UVC]), as shown in Figure. Generally, the shorter the wavelength, the greater the potential for light radiation to cause biological damage. Sunscreen filters are active against UVA1, UVA2 and UVB radiation. Chemical filters, such as oxybenzone, avobenzone, octocrylene and ecamsule, are aromatic compounds that absorb high-intensity ultraviolet radiation, resulting in excitation to higher energy states. When these molecules return to their ground states, the result is conversion of the absorbed energy into lower-energy wavelengths, such as infrared radiation (i.e., heat) [15].

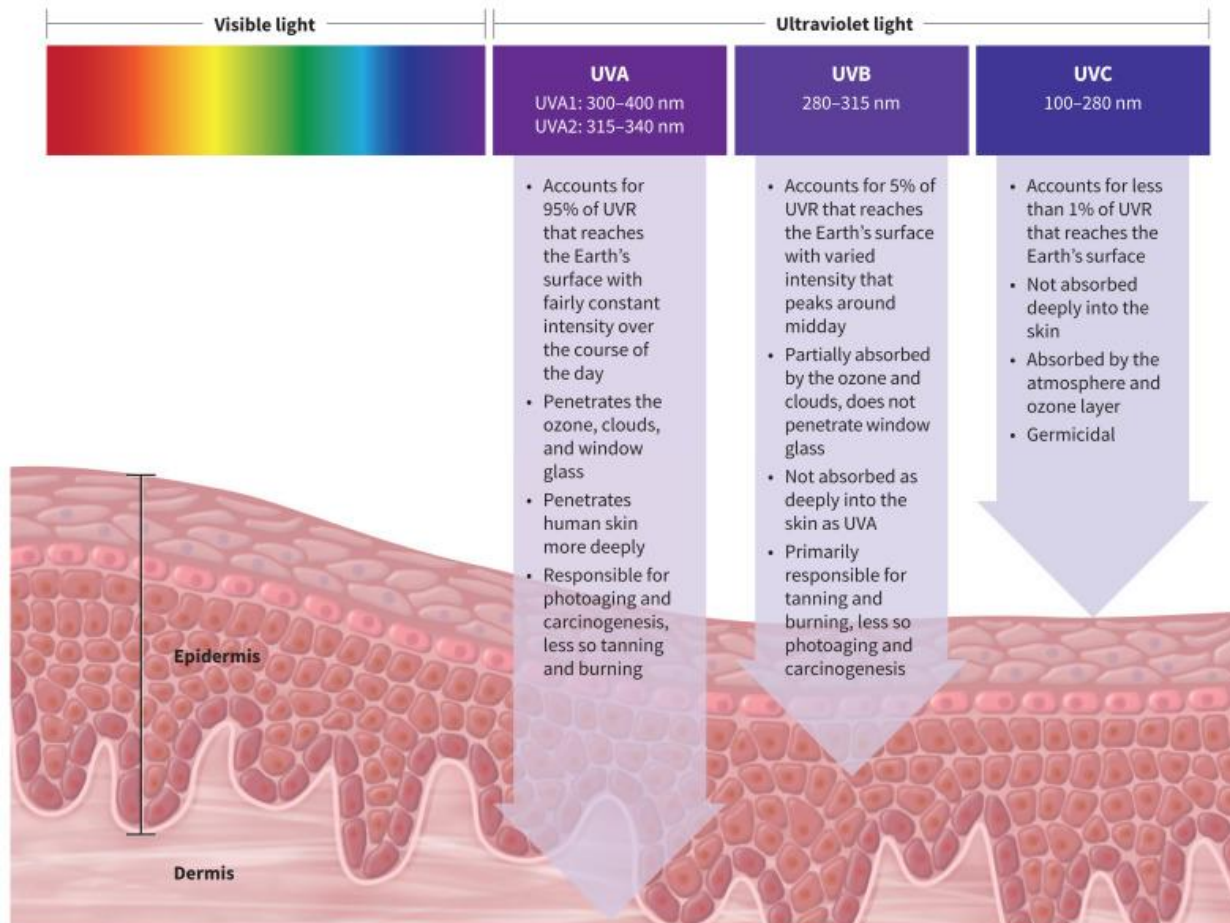


Fig.3. Schematic representation of the electromagnetic spectrum of light, emphasizing ultraviolet radiation (UVR) frequencies and their effect on human skin. Generally, the shorter the wavelength of radiation, the greater the potential for biological damage. Note: UVA = ultraviolet A, UVB = ultraviolet B, UVC = ultraviolet C. Sunscreen filters are active against UVA1, UVA2 and UVB radiation.

HERBAL COSMETICS: - Herbal cosmetics are formulated, using different cosmetic ingredients to form the base in which one or more herbal ingredients are used to cure various skin ailments. Therefore, various plants are being used for development of newer drug products for cosmeceuticals [16, 17].

HERBAL SUNSCREENS

As the global warming is increasing very rapidly, sun rays are becoming more and more dangerous. They can cause serious skin ailments like skin allergies, rashes, skin cancer etc. To protect the skin from the effects caused by the UV exposure, sunscreen products are used.

The active ingredients in the sunscreen mainly scatter, reflect or absorb the UV radiation, before it penetrate into the skin and prevents the components of skin from harmful solar radiations.

A sunscreen product is more or less like an umbrella which protects from the harmful effects of UV rays. The coating of sunscreen formulation on the skin should be uniform.

BENEFITS OF HERBAL SUNSCREEN

Numbers of people suffering from sunburn and skin sensitivity are very keen to use the products made from herbs, they do not want to use synthetic sunscreen preparations because of their side effects on the skin. The people nowadays are more interested in herbal products [18].

1. Reduce risk of skin cancer
2. Protect against sunburn
3. Avoid inflammation and redness
4. Avoid blotchy skin and hyperpigmentation
5. Stop DNA damage
6. Prevent the early onset of wrinkles and fine lines
7. Lower skin cancer risk
8. Shields from harmful UV ray.
9. Maintain the brightness of your natural complexion
10. Maintain the look and texture of your skin
11. Delays premature signs of aging
12. Reflects UVA and UVB rays
13. Works immediately when applied on the skin.

AN IDEAL HERBAL SUNSCREEN AGENT SHOULD HAVE FOLLOWING CHARACTERISTICS-

- 1) Absorb light preferentially over the range of 280nm – 320nm
- 2) Be stable to heat, light and perspiration
- 3) Be non-toxic and non-irritant
- 4) Not be rapidly absorbed
- 5) Be rapid soluble in suitable vehicle

The effectiveness of sunscreen preparations are based on the SPF factor. SPF is the sun protection factor found in sunscreen and sun block. According to the FDA, SPF is a measure of how much solar energy (UV radiations) are required to produce sunburn on protected skin relative to the amount of solar energy required to produce sunburn on unprotected skin [19, 20].

Table 3- Herbs Commonly Used In Herbal Sunscreen

COMMON NAME	LATIN NAME	DESCRIPTION
BAVCHI	<i>Psoralea corylifolia</i>	Improves skin health.
TURMERIC	<i>Cucurma longa linn</i>	It protects from free radical damage.
NEEM	<i>Azadirachta indica</i>	Treat acne, dry skin, redness, wrinkles
TOMATO	<i>Solanum lycopersicum. L</i>	Is a natural ingredient used in cosmetics and skincare products.
LEMMON	<i>Citrus limonum burm</i>	These constituents remove the dead cells, hair, and emollient action in sunburnt cells.
ALOE VERA	<i>Aloe barbadensis</i>	Moisturize the skin and soothe minor irritation
CENTUARY	<i>Erythraea centarium</i>	Skin conditioning

CONCLUSION

Exposure to ultraviolet radiation is directly harmful and has been associated with the development of skin cancers, which are common in Canada. High-quality evidence has shown that sunscreen reduces the risk of developing both melanoma and nonmelanoma skin cancer. Therefore, physicians should counsel patients on photoprotection strategies, including avoiding midday sun, seeking shade and wearing protective clothing, as well as using sunscreen if sun exposure cannot be avoided. Presently, the Canadian Dermatology Association recommends the use of a broad-spectrum sunscreen with an SPF of at least 30 for people older than 6 months, for photoprotection. Low-quality evidence has shown that some chemical sunscreen ingredients are systemically absorbed and may be contributing to environmental damage; people who are concerned may consider using physical sunscreens as an alternative. Research on the safety and efficacy of established sunscreens and novel agents is ongoing.

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