



E-ISSN: 2278-4136

P-ISSN: 2349-8234

[www.phytojournal.com](http://www.phytojournal.com)

JPP 2021; 10(2): 1460-1464

Received: 25-01-2021

Accepted: 28-02-2021

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## Ethnobotanical assessment of indigenous knowledge of plants used as sunscreen: A comprehensive review

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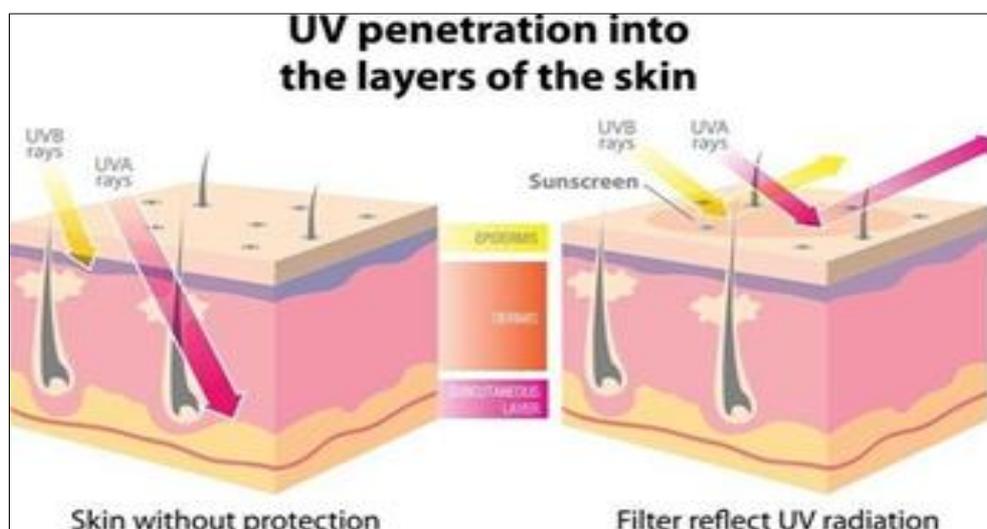
**Abstract**

The purpose of sun protective factor is a measure of how much solar energy (UV radiation) is required to produce sunburn on protected skin (i.e., in the presence of sunscreen) relative to the amount of solar energy required to produce sunburn on unprotected skin. The depletion of the ozone layer has increased our risk of sun damage from harmful UV rays. It Helps Maintain an Even Skin Tone: Sunscreen helps prevent discoloration and dark spots from sun damage, helping you maintain a smoother and more even skin tone. SPF is determined by the UV spectroscopy, *In vitro* SPF, Mansur equation. This review concludes damaging and harmful effects of UV rays, types of UV radiations along with brief information on role of sunscreen and advantages of various herbal remedies as sunscreen.

**Keywords:** TiO<sub>2</sub>, sunscreen, SPF booster, antioxidant, spectrophotometric method, herbal oils

**Introduction**

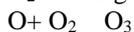
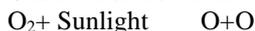
The purpose of sunscreen preparation is to resist skin from painful effects of sunburn and skin cancer. UV radiations shows damaging and harmful effects on skin. UVA and UVB rays causes skin melanoma, sun burn, photo ageing, skin pigmentation and various painful effects. Hence there is need of agents reported to have UV shielding effect. Generally sunscreens are used to protect skin from damaging effects of sun rays. Herbal sunscreens are ecofriendly with no comedogenic and side effects. Sunscreen known as sun blocker, sunburn cream etc. It is a topical product that absorbs or reflects some of the ultraviolet radiations on the skin exposed to sunlight and thus shows protection against sunburn. Solar ultra violet radiations (UVR) is divided into three categories: UV-C (200-280 nm), UV-B (280-320 nm) and UV-A (320-400 nm). UV-C is the most biologically damaging radiation, but it is filtered out by ozone layer. Currently UV-B radiation and to a lesser extent UV-A radiation are responsible for inducing skin cancer. Sunscreens and sun blocks are chemicals that absorb or block UV rays and show a variety of immunosuppressive effects of sunlight. The use of skin care products supplemented with several effective agents working through different pathways in conjunction with the use of sunscreens may be an effective approach for reducing UV-B-generated ROS-mediated photo-aging<sup>[1]</sup>.

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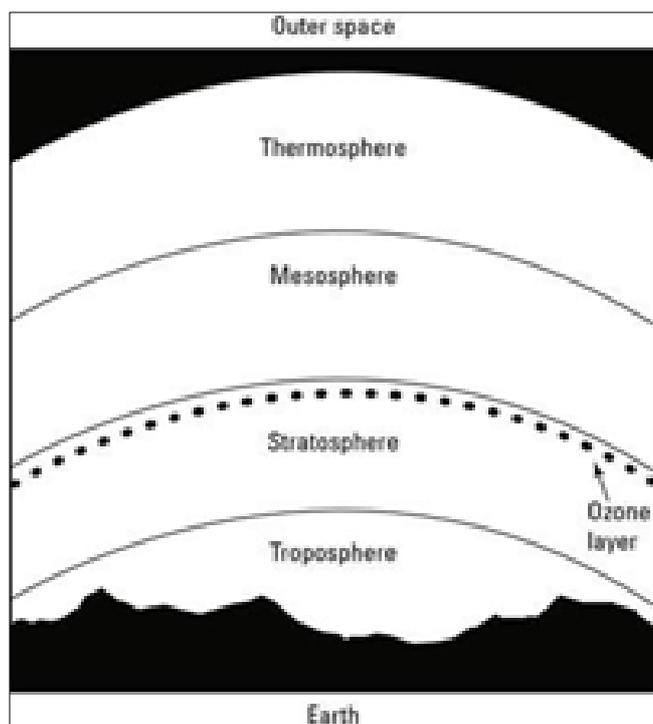
### Causes of ozone layer depletion

Bluish gas that is harmful to breathe. Nearly 90% of earth's ozone is in the stratosphere and referred to as the ozone layer. Ozone absorbs a band of ultraviolet radiation called UVB.



### Man-made causes

1. CFCs ( Chlorofluorocarbons)
2. Halons
3. Methyl chloroform
4. Hydrofluorocarbons (HFCs)
5. Natural causes



### Causes of UV radiation

This ozone absorbs the ultraviolet radiations from the sun which is harmful to living organisms. DNA and protein of living organisms absorb UV rays and its high energy breaks down the chemical bonds within these molecules. This causes damage to skin cells and skin cancer of different types (melanoma and non melanoma). High dose of UVB causes inflammation of cornea called snow blindness cataract [2].



### How UV Radiations Damage to human health?

UV radiations activate the cutaneous immune system, which led to an inflammatory response by different mechanisms.

The first line of defense mechanism against UV radiation is melanin (an epidermal pigment), and UV absorbing pigment of skin, which dissipate UV radiation as heat. UV rays, either from the sun or from artificial sources like tanning beds can cause sunburn. Exposure to UV rays can cause premature aging of the skin and signs of sun damage such as wrinkles, leathery skin, liver spots, actinic keratosis and solar elastosis. UV rays can cause eye problems, such as cornea {on the front of the eye to become inflamed or burned. Ultraviolet radiation is the major environmental harmful factor that affects human skin. It is well known that mitochondria can also be affected by UVB, leading to alterations in their membrane structure and permeabilization with cytochrome c release, which consequently affects the cell function [1].

### Sunscreen Role

Sunscreen are also known as Suntan lotion or sun block; the purpose of Sunscreen preparation is to resist skin from painful effects of sunburn and skin cancer. UV radiations shows damaging and harmful effects on skin. Generally, sunscreen is used to protect skin from damaging effects of sunrays. Diligent use of sunscreen can also help to slow or temporarily prevent the development of wrinkles, dark spot, sagging skin.

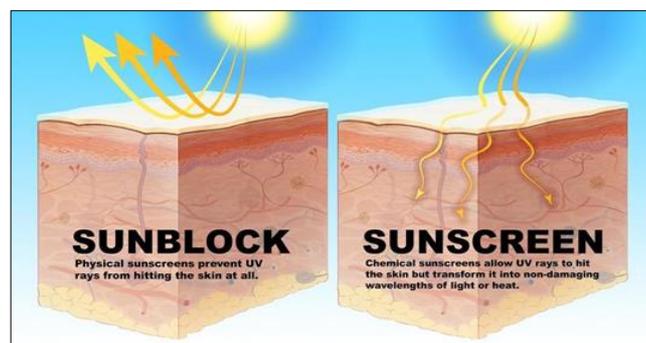
Depending upon the mode of action sunscreens can be classified into

#### Physical sunscreen

ZnO and TiO<sub>2</sub> which stay on the surface of skin and mainly deflects the UV light.

#### Chemical sunscreen

UV organic filter which absorbs the UV light.



Routine use of sunscreen may also reduce the risk of melanoma however many sunscreen do not block UVA radiation, yet protection from UVA is important for prevention of skin cancer. To provide a better indication of their ability to protect against skin cancer and other diseases associated with UVA radiation (phytophotodermatitis)

### Advantages of Herbal Sunscreens

- Easily available.
- No side effects.
- Absorbs radiation preferentially in the range of 280-320 nm.
- Are stable to heat, light and perspiration.
- Non-toxic, non-irritant. Not be rapidly absorbed.
- Rapid soluble in suitable alcohol. Neutral.
- Renewable sources.
- No special equipment is needed for preparation. Botanical equipments are easily available [3].

**Side effects of synthetic sunscreens**

However, they also have negative effects, including contact sensitivity, estrogenicity, photo allergic dermatitis, and risk of vitamin D deficiency. It has been reported that an increased incidence of melanoma may result from the use of sunscreen [1].

**Some of the side effects are mentioned below**

- Acne.
- Burning, itching, or stinging of the skin.
- Early appearance of redness or swelling of the skin
- Late appearance of rash with or without weeping blisters that become crusted, especially in sun-exposed areas, and may extend to unexposed areas of the skin.
- Pain in hairy areas.
- Pus in the hair follicles [4].

**Common Herbs used as a -Sunscreen**

Due to the side effects of synthetic or chemical sunscreen, herbal sunscreens are most commonly used today. For example, green or black tea, *Aloe vera*, walnut, tomato, myrobalan, carrot, lemon, pomegranate, apple, turmeric etc. [5].

**Green tea**

Biological source: *Camellia sinensis*, Family-Theaceae The basic chemical constituent in green tea includes catechins, vitamin E, tocopherols, carotinoids and polyphenolic compounds which shows potent antioxidant action and reported to be used as a herbal suncreening agent  
SPF value: 10.33 to 25.33

**Walnut**

Biological source: *Juglans Regia* Family – Juglandaceae Walnut is an edible seed of genus *juglans*. Walnut seeds basically contain amino acids, carbohydrates, unsaturated fatty acids; walnut oil is rich in polyunsaturated fatty acids, linolenic acid, linoleic acid, glyceryl triacylates and mostly antioxidants. Its aqueous extract has shown to be effective as a self-tanning sunscreen agent. Its main chemical constituent jug lone have reported to have action with keratin proteins of skin. Walnut is reported to have U.V rays protecting [6].

***Aloe vera***

Biological source: *Aloe vera*, Family – Xanthorrhoeaceae Due to its moisturizing and revitalizing activity, *Aloe vera* gel was widely used in cosmetic formulations. It is extracted from the leaves of *Aloe vera* and *Aleo barbadense* is are. Aloe extracts and aloin from *Aloe vera* have spectrophotometric peaks at about 297 nm and hence it can act as a sunscreen for skin and hair The photo protective activity of *Aloe vera* juice on hair was studied by measuring the content of tryptophan in the hair before and after treatment with *Aloe vera*, and exhibited that the hair untreated with aloe had higher level of chemical damage than that treated with *Aloe vera* juice, hence it can offer Protection from UV damage [7].  
SPF value: 0.0995

**Tomata**

Tomatoes contain extracts of polyphenolic, flavonoids, monoterpene and sesquiterpene, and saponins. It contains a lycopene as a derivate of terpenoid compound. Base on structure of lycopene, its showed as potent compound as strong antioxidant. Tomato shows strong protection against

neurodegenerative diseases, blocks U.V. radiations and reported to be used as a herbal screen agent [8].

SPF value: 1.3

**Myrobalan**

Biological source: *Terminalia chebulla* Family- combretaceae *Terminalia chebulla* basically contains various phytochemicals such as polyphenols,  $\alpha$ -tocopherols, anthocyanins, terpenes, flavonoids, alkaloids, and glycosides. It is reported to have therapeutic effect against skin disorders with discharges like allergies, urticaria and other erythematous disorders. A group of researchers have reported the inhibitory action on cancer cell growth. It is found that phenolics, chebulinic acid, tannic acid and ellagic acid were precisely used for unwanted cell growth. Aqueous extract of *Terminalia chebulla* inhibit xanthene oxidase activity and also reported to act as a scavenger of DPPH radicals. The strong antioxidant activity was studied by inhibition of radiation, lipid peroxidation, and scavenges hydroxyl and superoxide radicals and hence can be used as a U.V. Radiation

**Carrot**

Biological source: *Dacus carota*, Family- Apiaceae. Carotenoids are widely known as provitamin A, while there is an increasing interest in their role as antioxidants, Anti-cancer activity.

SPF value: 38 to 40

**Lemon**

Biological source: *Citrus limonum* Family- Rutaceae Oil is used for acne, cleaning greasy skin and hair, as well as removing dead skin cells and emollient effect on sun burnt skin cells.

SPF value: 30 (3)

**Lemongrass**

Biological source: *Cymbopogon citratus*, Family- Rutaceae It is concluded that lemon grass has high antioxidant capacity than many botanicals as it contains Principal compounds like neral, nerolic acid, geraniol, geranic acid and geranial in lemongrass oil [9].

**Pomegranate**

Biological source: *Punica granatum* Family- Lythraceae Pomegranate (*Punica granatum*) is having principle antioxidant polyphenones in its juice include the ellagic tannins and anthocyanins. Weerakkody P *et al*. Explained the effect of applying sunscreen treatments to pomegranate fruit on the degree of sunburn damage and the effect of maturity and sunburn on the internal antioxidant concentration of the juice [10].

SPF value: 1.0%

**Apple**

Biological source: *Malus domestica* Family-Rosaceae Apple is the pomaceous fruit of the apple tree. Apple peels are a source of various phytochemicals with unknown nutritional value and possible antioxidant activity *in vitro*. The predominant phenolic phytochemicals in apples are quercetin, epicatechin, procyanidin b-2 and many more flavonoids. This shows scavenging action towards free radicals produced due to U. V radiation [6].

**Turmeric**

Biological source: *Curcuma longa* Family- zingiberaceae Curcuminoids help to protect skin cells from free radical damage<sup>[7]</sup>.

**Various vegetable oil are also there which are used as a sun protection**

The use of vegetable oils with photo protective activity in sunscreen formulations would allow for decreasing the amounts of organic UV-filters, thus reducing the safety concerns and fulfilling the consumer demand for more natural products. Many herbal oils have been reported to show significant SPF values. i.e., Sesame oil, castor oil, sunflower oil, olive oil etc.<sup>[8]</sup>.

**Sesame oil**

Biological Source: *Sesamum indicum* Family- Pedaliaceae *In vitro* sesame oil has inhibited the growth of malignant melanoma (a skin cancer) prostaglandin and leukotrienes. It has potent antioxidant activity<sup>[9]</sup>.

SPF value: 4-1

**Castor oil**

Biological source: *Ricinus communis* Family-Euphorbiaceae It reduces various problems like sunburn, acne, dry skin, stretch marks etc. It penetrates deep into the skin and stimulates the production of collagen and elastin, which helps to soften and hydrate the skin<sup>[10]</sup>.

SPF value: 5.687

**Sunflower Oil**

Biological source: *Helianthus annuus* it retains moisture in the skin and protects skin from harmful U.V. radiations. The sunflower oil also contains Alphatocopherol concentration of 609 mg/kg. Alpha tocopherol (Vitamin E) in cosmetics acts as an antioxidant and protect against UV radiation. Alphatocopherol is very effective against UV-B free radical damage. Vitamin E absorbs strongly in the UV-B region of 280-320 nm (8).

SPF value: 19

**Olive oil**

Biological source: *Olea europaea* Family- oleaceae Olive oil has a long history of being used as home remedy for skin care. Squalene is used as a antioxidant, moisturizer and as a convenient vehicle to carry other substances in topical sunscreen preparation.

SPF value: 2-8

**Argan Oil**

Biological source: *Argania spinose* unroasted argan oil is traditionally used as a treatment for skin diseases and as cosmetic oil for skin. It is reported to have moisturizing, nourishing, UV protectant and autooxidising agent.

**Avocado Oil**

Avocado oil has a high proportion of mono-saturated fats, which provide a protective layer over the skin. Oil is high in nutrients to soothe and nourish dry, damaged skin. It promotes the production of collagen and protects the skin

against fine lines and wrinkles. It helps the skin to retain water to keep it firm and rejuvenated.

Avocado oil ranks in as high as SPF 15

**Wheat germ Oil**

Wheat germ oil is a great source of Vitamin E, K, and B and Choline. This is fantastic for moisturizing tissue and preventing free radical damage. The SPF rating of wheat germ oil comes in around 20.

**Methods used for determination of SPF**

The efficacy of a sunscreen agent or product is expressed by Sun Protection Factor (SPF) for UV B. SPF is defined as the UV energy required to produce a Minimal Erythema Dose (MED) in protected skin divided by the UV energy required to produce the same MED in unprotected skin<sup>[11]</sup>.

$$\text{SPF} = \frac{\text{Minimal erythema dose in sunscreen} - \text{protected skin}}{\text{Minimal erythema dose in non} - \text{sunscreen} - \text{protected skin}}$$

$$\text{SPF} = \frac{\text{Dosage MED with sunscreen}}{\text{Dosage MED without sunscreen}}$$

The minimal erythema dose (MED) is defined as the lowest time interval or dosage of UV light irradiation sufficient to produce a minimal, perceptible erythema on unprotected skin. The higher the SPF, the more effective is the product in preventing sunburn.

**Mansur equation**

Mansur *et al.* (1986), developed a very simple mathematical equation which substitutes the *in vitro* method proposed by Sayre *et al.*, (1979), utilizing UV spectrophotometry and the following equation<sup>[11]</sup>.

$$\text{SPF(Spectrometry)} = \text{CF} * \sum_{290}^{320} \text{EE}(\lambda) * \text{I}(\lambda) * \text{abs}(\lambda)$$

Where:

EE- erythemal effect spectrum

I-solar intensity spectrum

Abs-absorbance of sunscreen product

CF-correction factor<sup>[12]</sup>.

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