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Review Article

Natural Sunscreen Agents: A Review

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Abstract: The exposure of skin to ultraviolet B (UVB) radiation has a destructive effect on keratinocytes by causing DNA damage that can subsequently lead to malignant transformation. Cellular defense mechanisms against this injury begin with the immediate UVB-induced death of damaged cells. In less severely affected cells, cell-cycle progression can be blocked and DNA damage can be repaired through nucleotide excision repair (NER). If repair is successful and cells have not suffered irreversible damage, they will survive. In the absence of appropriate repair, keratinocytes undergo apoptosis, producing characteristic 'sunburn cells'. Sunscreen is defined as substance that protects the skin from excessive exposure to the ultraviolet radiation of the sun. Sunscreen use is often proposed for sun protection because of their ability to block UV-induced sunburns (the sun protection factor –SPF). It helps to prevent sunburn and reduce the harmful effects of the sun such as premature skin aging and skin cancer. They are routinely tested in humans and can be assigned a sun protection factor (SPF) which reflects their ability to prevent sunburn. Sunscreens are found in cream, lotion, gel, stick, spray, and lip balm type's forms. They are for external use only. An attempt has been made to review natural sunscreen agents.
Keywords: Sunscreen, Polyphenols, SPF, sunburns

INTRODUCTION

The use of sunscreen as photo protecting agents for UV protection is becoming very popular. A sunscreen preparation is defined as a formulation which, when applied topically, protects the treated area from sunburn. Sunscreens are used to aid the body's natural defense mechanisms to protect against harmful UV radiation from the sun. Its function is based on its ability to absorb, reflect or scatter the sun's rays. The Sun protection factor (SPF) of a sunscreen is calculated by comparing the amount of time needed to produce sunburn on sunscreen protected skin to the amount of time needed to cause sunburn on unprotected skin [1]. Efficacy of sunscreens depends on ability to protect against UV-induced sunburns, and their chemo preventive activity [2].

The ideal sunscreen compound has to meet a wide variety of specification.

- It must absorb or filter out the rays causing sunburn which are those in the region from 2900 to 3300 Angstroms.
- It should be stable in the presence of light, air, and moisture, or if it is decomposed under these conditions, the decomposition products should have comparable absorption to the original compound in the 2900 to 3300Angstrom region.
- It should have very slight or no absorption for the long ultraviolet rays beyond 3400 Angstroms which are thought to produce tanning without appreciable erythema.
- The compound and decomposition products which may be produced under conditions of use should be nontoxic and nonirritating.
- It should be nearly neutral so untoward effects are not produced by the presence of acid or base on the skin.
- It should have good solubility in the ointment base or vehicle in which it is to be formulated and should have low water solubility to prevent rapid removal by perspiration.
- It should be relatively nonvolatile so it will not evaporate under conditions of use.
- It should not be rapidly absorbed through the skin [3].

NATURAL SUNSCREENS

Aloe vera

The leaves of *Aloe vera* and *A. barbadensis*are the source of aloe vera gel. Aloe vera gel is widely used in cosmetics and toiletries for its moisturizing and revitalizingaction. It blocks both UVA and UVB rays and maintain skin's natural moisture balance. The enzyme bradykinase in aloes stops the sunburns and stimulate immune system intervention. Acemannan

which is D-isomer mucopolysaccharides peeds up the repair phase and the increased production of fibroblasts and collagen. Aloe extracts and aloin from the plant have spectrophotometric peaks at about 297 nm and hence can act as a sunscreen for skin as well as hair [4, 5, 6].

The study was carried out to determine the photo protective activity of Aloe vera juice on Asian hair namely Black, grey which are chemically colored. Tryptophan content of hair treated with aloe vera juice before and after exposure to UV radiation. The tryptophan content measurements revealed that hair which was untreated and exposed showed higher degree of chemical damage while treated with Aloe vera juice offered protection from UV damage [7].

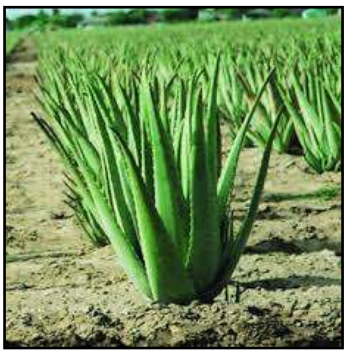

Figure1: Aloe

Tomato

Tomato *(Lycopersiconesculentum)* fruit is the major source of lycopene and studied for its antioxidant activity incosmetic and pharmaceutical field. Tomato is rich in lycopene, a widely studied powerful antioxidant and anti-carcinogenic carotenoid with strong reducing ability. Lycopene is a carotenoid, which gives red color to the tomatoes. It is not merely a pigment but a powerful antioxidant, neutralizes free radicals especially those derived from oxygen, present under the lipid membrane and skin cover. Lycopene scavenges lipid radicals, reduces lipid peroxidation, and prevents erythema caused by UV radiation on the skin. Lycopene may reduce the damaging effect which UV light can have on the skin and can boost protection against both the short term (sunburn) and cumulative effects of sun exposure (cancer) [8, 9, 10].

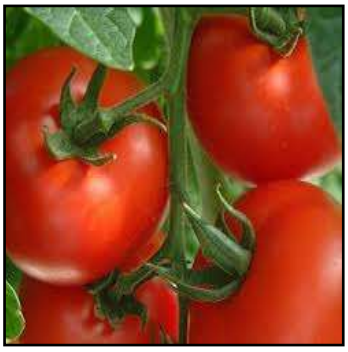

Figure 2: Tomato

Pomegranate

Pomegrante (*Punica granatum*) is having principle antioxidant polyphones in its juice include the ellagitanninsandanthocyanins. 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. They evaluated effectiveness of three commercial sunscreen treatments Parasol1 (Crop Care, Australia), Surround1 (Ag Nova Tech., Australia) and Anti-stress-5001 (EnviroShield Products Co., USA) For preventing sunburndamage of pomegranate, fruit was grown in Condobolin, New South Wales, Australia. The results showed that there was a significant effect of the sunscreen treatments ($p = 0.05$) for the severely sunburn damaged fruit category. Fruit treated with Surround1 (14.7%) andParasol1 (12.8%) had significantly lower numbers of fruit with severe damage compared to the control fruit (25.8%); the effect using the anti-stress 5501 (19%) was not significant [11,12].

Figure 3: Pomegranate

Green Tea

Green tea is obtained from the fresh leaves of the plant *Camellia sinensis*. Polyphenols are thought to be the major chemo preventive mediators. Green tea contains four major polyphenols: (-)-epicatechin (EC), (-)-epicatechin-3-gallate (ECG), (-)-epigallocatechin (EGC), and (-)-epigallocatechin-3-gallate (EGCG). It also contains other agents include caffeine, flavonoids, phenolic acids as well as the alkaloids the obromine and theophylline. The first evidence that green tea polyphenols might have a protective role in UV-induced skin cancer came from studies by Wang et al., who showed that green tea administered in the drinking water to SKH-1 hairless mice had a dose-dependent prolongation in the mean time of tumor development when they were subjected to a photo carcinogenesis protocol. Very little absorption by green tea in the UVB or UVA range; it is effective when given systemically; and protection against at least some of the biological effects of ultraviolet radiation occur when green tea is applied immediately after exposure [13,14,15].

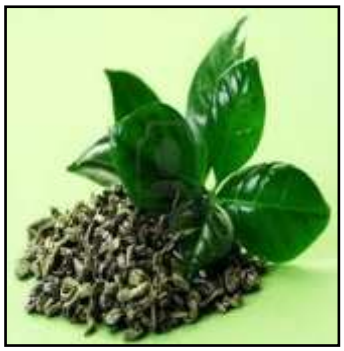

Figure 4: Green Tea

Topical green tea extract significantly increased the minimal erythema dosage of UV on healthy human skin and reduced signs of UV damage on that skin.(-)-Epigallocatechin-3-gallate (EGCG) and (-)-epicatechin-3-gallate (ECG) were reported to be the most active components. In several mouse skin models, topical application as well as oral consumption of green tea has been shown to afford protection against chemical and UVB-induced carcinogenesis and inflammatory responses. Human skin was investigated against topical application of (-) epigallocatechin-3-gallate (EGCG), the major polyphenolic constituent in green tea. It inhibited UVB-induced infiltration of leukocytes (macrophage/neutrophils), a potential source of generation of reactive oxygen species (ROS), and generation of prostaglandin (PG) metabolites. Human were subjected to UVB irradiation on sun-protected skin to four times their minimal erythema dosage (MED) and skin biopsies or keratomes were obtained either 24 h or 48 h later. Study revealed that topical application of EGCG (3 mg/2.5 cm^2) before UVB (4 MED) exposure to human skin significantly blocked UVB-induced infiltration of leukocytes and reduced myeloperoxidase activity [16, 17].

Cucumber

Cucumber (*Cucumissativus*) extract has strong moisturizing abilities as well as mild astringent effects. It also helps remove dead skin cells and tightens skin. Cucumbers soothe skin irritations, prevent water retention and are rich in water, fiber and beneficial minerals. Cucumber also contains ascorbic acid (vitamin C) and caffeic acid, both of which soothe skin irritations. These two acid compounds prevent water retention, which is why cucumbers applied topically are helpful for swollen eyes, burns and dermatitis.

Figure 5: Cucumber

Hogade Maheshwar et al evaluated the correlation between natural fresh (Cucumber) and marketed cucumber lotion as sun protective agent. Marketed cucumber product was randomly selected and compared with fresh cucumber extracts by making different dilution (100 & 200µg/ml) in ethanol. The absorbance's of all aliquots were recorded at different nm with the 5 nm intervals from 250-350 nm. The in-vitro SPF values were determined at wavelength from 290-320 nm according to the method discussed by Mansur et al and found positive results [18, 19].

Grapes

Grapes fruit (*Vitisvinifera*) are the richest source of polyphenols (60%-70%). The skin and seeds of grapes also contains the polyphenolicphytoalexin namely resveratrol (trans-3, 5, 4'-trihydroxystilbene). It is an excellent antioxidant with strong anti-inflammatory and antiproliferative activity [20].

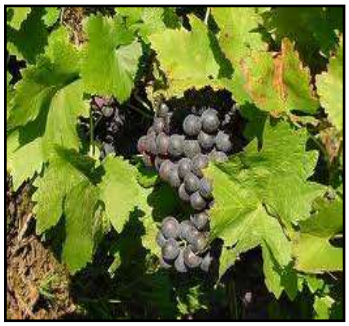

Figure 6: Grapes

Indian Beech Tree

The sunscreen activity of various solvent (Aq, methanol and acetone) extracts of leaves of *Pongamiap innata* was compared with the standard sunscreen drug *p*-aminobenzoic acid. The absorption spectra of various solvent extracts of this plant were measured using UV-visible spectrophotometer. The aqueous and methanol extracts were found to be highly effective in UVB region and moderately effective in UVA region. Acetone extract was found to greatly absorb exclusively in the UVA region. The extracts of leaves of this plant are showing good absorbance throughout the UV region including UVA region. Hence, *P. Pinnata* extract can be used to formulate highly effective sunscreen preparations [21].

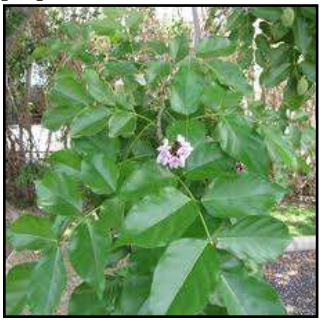

Figure 7: Indian Beech Tree

Almond

Almond is commercially known as almonds. Seeds are rich in polyphenolic compounds especially flavonoids and phenolic acids. The UVB protective property of this plant's skin extract was tested. The mice was exposed to UVB radiation and analyzed for changes in lipid peroxidation and glutathione levels. Topical application of formulated cream to mice after irradiation and 2 hprior to irradiation showed the decreased levels of lipid peroxidation and increased levels of glutathione. The results showed that topical application of cream formulation has significant antioxidant and anti-photo aging properties [22, 23, 24].

Figure 8: Almond

African tulip tree

African tulip tree (*Spathodeacamp anulata*) is an ornamental plant along the roadsides of tropical Africa. The plant stem bark was previously reported to have anti-hyperglycemic, antimalarial, antioxidant as well as wound healing properties.Patil VV et al evaluated methanolic extract of flower of *Spathodeacamp anulata* for its anti-solar activity. The extract showed a prominent absorbance at 200-240 nm, while good absorbance at a range of 240-325 nm. The moderate absorbance was noted at the range of 310-340 nm. The result revealed the ability of extract to absorb UV radiation and hence proved its UV protection ability. This plant makes it as a better and safe alternative to harmful chemical sunscreens[25].

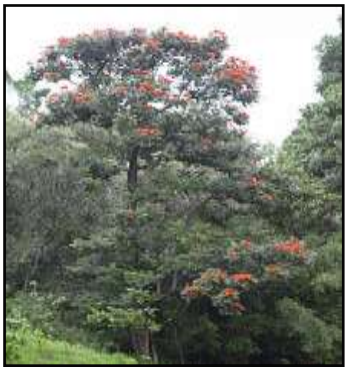

Figure 9: African tulip tree

Saffron

Golmohammadzadeh SH et al evaluated saffron for its anti-solar activity. The pollens of the saffron (*Crocus sativus*) were dried and powdered in a grinder. The experimental formulations included a homosalate (8%) lotion reference, lotions with 2, 4 and 8% of grinded saffron, and the control lotion base without saffron. The lotions containing saffron were prepared like homosalate lotion reference according to FDA. The sun protection factors (SPFs) of the formulations were determined by an in vitro spectrophotometry method. The results of this study indicated that saffron can be used as a natural UV-absorbing agent [26].

Figure 10: Saffron

Natural Sunscreen Oils

Shea butter

Shea Butter (*Vitellariaparadoxa*) is derived from the fat of the shea nut. The shea tree is native to the savannahs of Africa. Shea butter melts at body temperature and absorbs rapidly into the skin without leaving a greasy feeling. It contains the antioxidants, vitamins A and E both of which enhances skin cell regeneration and promote blood circulation below the skin's surface. Cinnamic acidin the oil provides vital protection against harmful UV rays.

Figure 11: Shea butter

Jojoba Oil

Jojoba (*Simmondsiachinensis*) is a desert shrub effective for treating eczema, psoriasis and dry skin. The oil of jojoba is effective as a moisturizer for dry skin and contains a natural plant chemical called myristic acid which provides some limited sun protection. Jojoba oil has a low SPF of 4.

Figure 12: Jojoba

Carrot Seed Oil

Carrot (*Daucuscarota*) seed oil is an essential oil with significant antioxidant, antiseptic, antifungal and fragrant properties with high levels of vitamin A. When applied topically to the skin in the form of diluted carrier oil, carrot seed oil also provides natural sun protection. According to a study published in "Pharmacognosy Magazine" in 2009, products containing carrot seed oil have a natural SPF of 38 and 40.

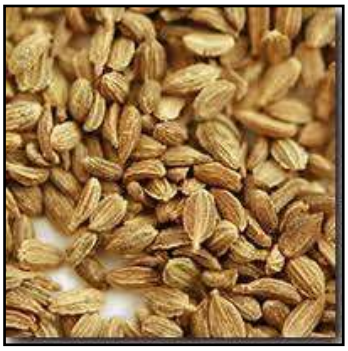

Figure 13: Carrot seed

Soybean Oil

Soybeans (*Glycine Max*) are a nutritious and cost-effective addition to sunscreen. Soybeans originally come from China and are a rich source of essential fatty acids, protein, lecithin, iron and calcium in the diet. When used topically on the skin, soybean oil is a cost-effective moisturizer compared to other oils and has a natural SPF of 10 [27].

Figure 14: Soybean

Evening primrose oil

Evening primrose (*Oenothera* spp.)oil has a high γ-Linolenic acid content that promotes healthy skin and skin repair. It is usually yellow in color. It soothes skin problems and inflammation, making it a good choice for people with eczema, psoriasis, or any type of dermatitis. Evening primrose skin oil discourages dry skin and premature aging of the skin[28, 29].

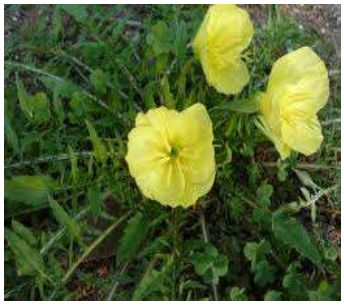

Figure 15: Evening Primrose

Conclusion

From long back, the use of chemicals in sunscreens as photoprotective agent in the formulation isa common practice. Owing to their harmful effects, they are becoming less popular now a day. The use of Natural sunscreen has been gaining significant attention of researchers due to their safety, multiple biological actions on the skin and cost effectiveness. The additive properties exerted by the phytoconstituents of plant make them as the most suitable ingredient for sunscreen formulations. The plant actives are preferred over the chemical sunscreens due to the broad spectrum of UV absorption, protective effect against oxidative stress, inflammation and cancer.

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