

**REVIEW ON HERBAL PLANTS HAVING
SUNSCREEN AND ANTIOXIDANT ACTIVITY**

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Summary

Several studies have shown that UV radiation on the skin results in the formation of reactive oxygen species (ROS) that interact with proteins, lipids and DNA, thus altering cellular functions. The epidermis is composed mainly of keratinocytes, rich in ROS detoxifying enzymes and in low-molecular-mass antioxidant molecules. However, the increased generation of ROS can overwhelm the natural defences against oxidative stress [1]. Among all the alternatives available sunscreens are the best alternatives to prevent the UV induced damage to skin. Sunscreens are widely used as photo protective agents. They are divided into chemical sunscreens which absorb high energy UV radiations and physical blockers which reflect or scatter light. Treatment of the skin with products containing plant-derived antioxidant ingredients may be a useful strategy for the prevention of UV-mediated cutaneous damage [2, 3]. In the following review various plants having sunscreen activity have been discussed.

Keywords: Sunscreen, Antioxidant, UV radiations

Introduction

India has a glorious tradition of the arts and science of healing. Our ancient literature has references of plants reported to cure difficult and incurable disease. In charak samhita numerous herbs like nagakeshara (*Mesua ferrea Linn*), Padmaka (*Prunus serotina*) yashtimadhu (*glycyrrhiza glabra Linn*) Manjistha (*Rubia cardifolia linn*) etc. were described for glowing complexion and for other skin disorders. Many plant products like extracts, oils and powders have been used in cosmetics as either active moieties or as excipients [4]. In the present review we are discussing some plants which are used for their sunscreen and skin whitening activity. Preparations containing herbal ingredients are gaining popularity nowadays because of several advantages as within them exist hundred of botanicals which contain bioactive phytochemicals which improve the skin conditions to considerable extent without any side effects No other ingredient can serve this purpose as effectively as botanicals [5]. Human beings are daily exposed to ultraviolet (UV) radiation from the sun; being situated at the interface between the body and its environment, the skin directly suffers from the deleterious effects of UV radiation. UVB (280–320nm), regarded as “the burning rays”, makes up 4%to 5% of UV light but is also the most active constituent of solar light [6]. One has to mention that higher plants are naturally exposed to solar radiation and therefore to relatively high doses of UV radiation; thus they have developed a number of defence mechanisms against UV-induced damage, such us the capability to absorb UV radiation by accumulation of phenolic compounds in their superficial layers.

Sunscreens are the best alternatives to prevent sunburns or to prevent the skin from deleterious effects of UV rays. Preparations containing herbal ingredients or extracts can be prepared as they are safe to use because they contain natural substances having less side effects, are renewable sources, are under GRAS (Generally Regarded as Safe) category, and are less expensive. Because of all above benefits several plant compounds have gained considerable attention as skin protective agent.

Sunscreens

Sunscreen protects against the damaging effects of the sun by reducing the amount of ultraviolet (UV) rays that reach the skin. Sunscreen works by filtering (not blocking) UV radiation with a chemical barrier that absorbs and/or reflects the UV rays away from your skin. No sunscreen provides 100% protection against UV radiation. Some UV radiation will always reach the skin, damaging the cells below. This damage builds up over time and can increase the risk of skin cancer. Ultraviolet radiation is a small component of the electromagnetic spectrum with a narrow band of radiation from 200-400 nm. The UV spectrum is further divided into UVC (200-290 nm), UVB (290-320 nm) and UVA (320-400). UVA rays constitute 90-95% of the ultraviolet light reaching the earth. They have a relatively long wavelength (320-400 nm) and are not absorbed by the ozone layer. UVA light penetrates the farthest into the skin and is involved in sun tanning. UVA tends to suppress the immune function and is implicated in premature ageing of skin. UVB rays are partially absorbed by the ozone layer and have a medium wavelength (290-320 nm). They do not penetrate the skin as far as UVA rays do and are the primary cause of sunburn. They are also responsible for photo ageing and photo carcinogenesis [3].

Sunscreens have been divided into chemical absorbers and physical blockers on the basis of their mechanism of action. Chemical sunscreens are generally aromatic compounds conjugated with a carbonyl group. This general structure allows the molecule to absorb the high energy ultraviolet rays and release the energy as lower energy rays, thereby preventing the skin damaging ultraviolet rays from reaching the skin. So upon exposure to UV light, most of the ingredients do not undergo significant chemical change. This allows these ingredients to retain the UV absorbing potency without significant photo degradation, thereby preventing the skin damaging ultraviolet rays from reaching the skin and physical blockers reflects or scatter the light [3].

Ability of sunscreen against protection to sunburns depends upon optimizing water resistance capacity and its SPF rating [7]. SPF stands for 'sun protection factor'. The SPF protects against UVB radiation. A sunscreen is given an SPF number (of between 4 and 30+) after strict laboratory testing. The higher the SPF number, the more protection the sunscreen provides against sunburn. A sunscreen with a SPF of 15 provides >93% protection against UVB. Protection against UVB is increased to 97% with SPF of 30+. The difference between a SPF 15 and a SPF 30 sunscreen may not have a noticeable difference in actual use as the effectiveness of a sunscreen has more to do with how much of it is applied, how often it is applied, whether the person is sweating heavily or being exposed to water. Hence a sunscreen with SPF 15+ should provide adequate protection as long as it is being used correctly. However, most people apply their sunscreen at about one third the thickness used for testing; they fail to apply it to all exposed areas of skin; and they forget to reapply it every couple of hours. Therefore, the actual protection may be a lot less than the tests [2].

TABLE 1: Plants used for sunscreen & antioxidant activity

| S No | Plant | Botanical Name | Part Used | Active Chemical Constituent |
|------|-----------|-------------------------------|-----------|----------------------------------------|
| 1 | Cucumber | <i>Cucumis sativus</i> | Fruit | Ascorbic & caffeic acid |
| 2 | Liquorice | <i>Glycyrrhiza glabra</i> | Roots | Glycyrrhizin & Glycyrrhetic acid |
| 3 | Turmeric | <i>Curcuma longa</i> | Rhizomes | Curcumin & tetrahydrocurcumin |
| 4 | Green tea | <i>Thea viridis</i> | Leaves | (-)-Epigallocatechin-3-O-gallate(EGCG) |
| 5 | Rosemary | <i>Rosmarinus officinalis</i> | Sticks | Urnolic & carsolic acid |

| | | | | |
|----|-----------------|--------------------------------|-------------------------|----------------------------------------------------------|
| 6 | Peppermint | <i>Mentha piperita</i> | Leaves | Menthol, menthone & 1,8-cineol |
| 7 | Horse chest nut | <i>Aesculus hippocastanum</i> | Bark & seeds | Aesculin & aescin |
| 8 | Ginkgo | <i>Ginkgo biloba</i> | Leaves | sciaopitysin, ginkgetin & isoginkgetin |
| 9 | Tomato | <i>Lycopersicon esculentum</i> | Fruit | Lycopene & beta carotene |
| 10 | Rice | <i>Oryza sativa</i> | Bran | gamma-Oryzanol & ferulic acid |
| 11 | Aloe Vera | <i>Aloe barbadensis</i> | Leaves | Barbaloin, isobarbaloin & anthraquinones |
| 12 | Carrot | <i>Daucus carota</i> | Roots | beta-Carotene |
| 13 | Saffron | <i>Crocus sativus</i> | Flowers & dried stigmas | Safranol & crocin |
| 14 | Amla | <i>Embelica officinalis</i> | Fruits, leaves & bark | Vit. C & tannins |
| 15 | Calendula | <i>Calendula officinalis</i> | Flowers | Triterpene saponins & carotenoids (leutin & zeaxanthine) |
| 16 | Ashwagandha | <i>Withania somnifera</i> | Leaves & roots | Chlorogenic acid & rutin |
| 17 | Mimosa | <i>Mimosa tenuiflora</i> | Bark | Bioflavonoids |
| 18 | Pomegranate | <i>Punica granatum</i> | Seeds & fruit peel | Ellagic acid |
| 19 | Arnica | <i>Arnica montana</i> | Dried flower heads | Helenanin |
| 20 | Betel nut | <i>Areca catechu</i> | Seeds | Arcane, |

| | | | | |
|----|-------------|--------------------------|-------------------|--------------------------------------|
| | | | | arecolidine & guvacine |
| 21 | Neem | <i>Azadiracta indica</i> | Whole plant | Nimbin & margosine |
| 22 | Garlic | <i>Allium sativum</i> | Bulbs | S-allyl cysteine, alliin & allicin |
| 23 | Grape fruit | <i>Vitis vinifera</i> | Fruits & leaves | Xanthophyll |
| 24 | Rose | <i>Rosa damascena</i> | Flowers | Polyphenols (citrenellol & geraniol) |
| 25 | Lavender | <i>Lavandula vera</i> | Flowering tips | Linalyl acetate, geraniol & cineole |
| 26 | Almond | <i>Prunus amygdalus</i> | Ripe seed kernels | Oleic & linoleic triglycerides |
| 27 | Tulsi | <i>Ocimum sanctum</i> | Leaves | Polyphenols |

Various Plants Having Sunscreen and Antioxidant Activity

Cucumber (*Cucumis sativus*) [8]



The flesh of cucumbers is primarily composed of water and cucumber juice which is often recommended is a rich source of silica to improve the complexion and health of the skin, plus cucumber's high water content makes it naturally hydrating—a must for glowing skin. Cucumbers are also used topically for various types of skin problems, including swelling under the eyes and sunburn. Two compounds in cucumbers, ascorbic acid and caffeic acid, prevent water

retention, which may explain why cucumbers applied topically are often helpful for swollen eyes, burns and dermatitis. It also contains ascorbic acid (vitamin C) and caffeic acid, both of which help soothe skin irritations and reduce swelling [8].

Liquorice (*Glycyrrhiza glabra*) [9]



A powerful skin protectant, liquorice has anti-inflammatory, immune-boosting, and anti-cancer effects, including protecting against DNA damage. Liquorice extract also has demonstrated efficacy in treating atopic dermatitis, an - allergy-related, intensely itchy swelling of the skin. Glycyrrhizin, the main component of liquorice root, protects against UV-B light induced damage in the context of human melanoma cells. Glycyrrhetic acid, another constituent of liquorice, protects against skin tumour initiation and promotion in a validated model of skin cancer. An extract of liquorice called glabridin reduces inflammation resulting from UV light exposure. In fact, when a liquorice extract rich in glabridin was applied to the skin before exposure to UV light, it helped prevent the redness and pigmentation that would normally have occurred. Liquorice extract also reduces melanin synthesis, suggesting that it may have applications in preventing and fading unsightly “age spots,” or areas of hyper-pigmented skin. The depigmentation property of liquorice is due to its ability to inhibit the tyrosinase activity of melanocytes [10, 11, 12, 13].

Turmeric (*Curcuma longa*) [14]

Curcumin is fast becoming known as a cure-all nutrient, and for good reason. Derived from the pungent spice turmeric, curcumin has excellent anti-inflammatory and antioxidant properties. Curcumin inhibits cancer initiation and promotion in validated cancer models. Curcumin induces the powerful tumour suppressor gene p53 and promotes the death of basal cell skin cancer cells. Studies suggest that topical curcumin may benefit the skin, the staining properties of its bright yellow native pigment have prevented its widespread use in topical products.

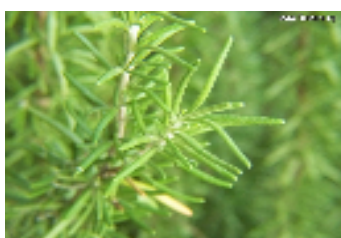
Fortunately, a major metabolite of curcumin called tetrahydrocurcumin does not possess the staining characteristics of native curcumin, yet it demonstrates anti-cancer effects that are similar to those of native curcumin. In fact, validated skin cancer models have shown that tetrahydrocurcumin inhibits skin cancer promotion. Laboratory studies indicate that topical tetrahydrocurcumin is a safe and effective skin-lightening agent. Skin-lightening agents help fade sun-induced areas of hyperpigmentation, or skin darkening. Many such agents work by inhibiting tyrosinase, a key enzyme involved in melanin synthesis. Thus, the colourless turmeric root derivative tetra-hydrocurcumin may help protect the skin against the detrimental effects of UV light and may help prevent (or fade) hyperpigmented areas of skin [12, 13, 15].

GREEN TEA (*Thea viridis*) [16]



Deriving the health benefits of green tea is not limited to drinking it or taking it in the form of a high-potency extract. Topical administration likewise provides great benefits, including protecting against damage that can contribute to skin cancer and skin aging. EGCG, a prime component of green tea, provides broad-spectrum protection against UV light-induced DNA damage and immune system dysfunction of the skin. Topical green tea extract is exceptional in preventing the inflammation and oxidative stress associated with UV light-induced skin damage. As a result, scientists believe green tea may help prevent skin cancers that commonly result from exposure to the sun's radiation. Exciting data from validated models of skin cancer strongly suggest that topically applied green tea extract can reduce the incidence and size of skin tumours. Importantly, this protection occurred even when green tea was applied following (not just before) UV light-induced damage. Thus, green tea may not only help prevent damage from UV rays, but also may help repair damage that has already occurred [12, 13, 15, 17, 18, 19].

ROSEMARY (*Rosmarinus officinalis*) [20]



The aromatic herb rosemary is particularly rich in carnosic and ursolic acids, two potent antioxidant and anti-inflammatory agents. More than a decade ago, scientists found that carnosic and ursolic acids effectively prevent skin cancer in a validated model of human skin cancer carcinogenesis. Ursolic acid acts powerfully and inhibits reactive oxygen species in skin cells and prevents damage from the skin-aging effects of UV-A light [12, 21].

PEPPERMINT (*Mentha piperita*) [22]



Peppermint oil extracted from the fresh or partly dried plant has many properties. The chemical components of peppermint oil are menthol, menthone, 1, 8-cineole, methyl acetate, methofuran, isomenthone, limonene, b-pinene, a-pinene, germacrene-d, trans-sabinene hydrate and pulegone. Peppermint oil is non toxic and non irritant in low concentrations. On the skin, peppermint oil is used to relieve skin irritation and itchiness and also helps to reduce skin redness, where inflammation is present. It is used for dermatitis, acne, ringworm, scabies and pruritus and also relieves itching, sunburn and inflammation of the skin, while at the same time having a cooling action [23, 24].

HORSE CHESTNUT TREE (*Aesculus hippocastanum*) [25]



The main constituents responsible for antioxidant activity are aesculin (a coumarin derivative) and aescin (a saponin). These constituents are obtained mainly from bark and seeds. The main action of horse chestnut is to provide protection against UV-A rays and thus providing the sunscreen effect against the photodamage [26].

GINKGO (*Ginkgo biloba*) [27]



The main constituent responsible for sunscreen activity in ginkgo are terpenes, pro-anthocyanidines, heterosides, and bioflavones, the most common of which are sciaopitysin, ginkgetin, isoginkgetin, bilobetin and ginkgolic acid. In man dietary supplementation with ginkgo extracts for 14 days indicated that the extract was slightly less effective than selenium but more effective than β -carotene and vitamin E as an oxidative scavenger. The main part used is leaf containing high amount of active ingredients [13, 15].

TOMATO (*Lycopersicon esculentum*) [28]



Tomato, another 'red' plant contains carotenoids as well, however, in this case the active material lycopene is another carotenoid that is four times more powerful than α -carotene and ten times more portent than β -carotene. Besides the

classical plant active principles like polyphenols and proteins, are also extracted, in a significant quantity, compounds having high bacteriostatic properties (tomatine). Lycopene is obtained from fresh tomato fruit [13, 15, 29, 30].

RICE (*Oryza sativa*) [31]



Rice is full of many interesting ingredients, especially ferulic acid, *gamma*-oryzanol and phytic acid, which are found concentrated in the rice bran and its oil. The *gamma*-oryzanol is believed to be the most active component responsible for rice bran's anti-oxidant effect [13, 15].

ALOE VERA (*Aloe barbadensis*) [32]



Chemical constituents are glucoside and isobarbaloin and barbaloin, free anthraquinones like emodin, iso-emodin, quercetin, rutin and chrysophanic. Two types of exudates are secreted by aloe leaves. One is a bitter reddish-yellow juice contained in the pericyclic cells located under the strongly cutinized epidermis of the leaves. This "juice" has been generally used for laxative purposes and, in dried form, is the officially recognized Aloe of the United States Pharmacopeia. Its bitterness is due to the presence of aloin, aloe-emodin and related compounds. The other exudate is a transparent, slippery mucilage or gel produced by the thin-walled tubular

cells in the inner central zone (parenchyma) of the leaf. The raw "gel" resembles colourless gelatine with hair like connective matrices and is also sometimes called "juice." In antiquity, this mucilage was applied to inflamed skin and also used on radiation burns. The main part of the plant used for sunscreen activity is leaves of aloe vera [13, 33].

CARROT (*Daucus carota*) [34]



The main active constituent responsible for sunscreen and antioxidant activity is beta carotene. It is obtained from the fresh fully grown carrots. The humble carrot is full of an orange substance called β -carotene. This material is also known as provitamin A and is often used in UV sunscreen preparations as a boost to the efficacy of the product. It has long been known that this material is also a powerful antioxidant. Up to 5% oil tincture is used in sun preparations to achieve desirable activity against sunburns. Carrot oil clears the complexion; it gradually dissolves the hardened (cornified) cores of blackheads [13, 15].

SAFFRON (*Crocus sativus*) [35, 36]



The active chemical constituents responsible for sunscreen activity are safranols and carotenoid glycosides- crocin-1, crocin-2, crocin-3 and crocin-4 esters. The main part used in sunscreen preparations are extracts obtained from saffron flowers. Carotenoids are lipid soluble substances and are membrane associated high efficiency free radical scavengers [37].

AMLA (*Embelica officinalis*) [38]



Fruit of amla is a rich source of vitamin C but it was proposed that superior effect of the mistaken "vitamin C" component is actually the more stable and potent anti-oxidant effect of the tannins that appeared to be the vitamin. The vitamin value of amla increased further when the juice was extracted from the fruit. The fruits, leaves and bark are rich in tannins. The root contains pelagic acid and lapel and bark contains leucodelphinidin [39, 40].

CALENDULA (*Calendula officinalis*) [41]



The flowers of calendula possess several medicinal uses. The active constituents present are triterpene saponins, carotenoids (lutein and zeaxanthine) which are responsible for having

sunscreen action. Traditionally herbal medicinal products are used for the symptomatic treatment of minor inflammations of the skin such as sunburn and as an aid in healing of minor wounds. The butanolic fraction of *Calendula* flowers possesses a significant free radical scavenging and antioxidant activity [42].

ASHWAGANDHA (*Withania somnifera*) [43]



The main parts of the plant used are leaves and roots. The active constituent chlorogenic acid and rutin which are found in abundant amounts in the leaves and roots are responsible for the preventive action against harmful UV radiations from the sun and thus acting as a powerful sunscreen agent [44].

MIMOSA (*Mimosa tenuiflora*) [45]



This species of mimosa is known as the skin tree or Tepezcohuite or *Mimosa tenuiflora*. The main part of the plant used for medicinal or cosmetic purpose is bark. The bark is rich of tannins and flavonoids; flavonoids being the main constituent responsible for antioxidant activities. It is recommended for activity, sun or after-sun protection products. [46]

POMEGRANATE (*Punica granatum*) [47]

Main parts of *punica granatum* used are seed and peels. Pomegranate extract is primarily composed of alkaloids and polyphenols. The active constituent that appears to be responsible for its multiple health benefits is Ellagic Acid. Ellagic Acid is a naturally occurring phenolic compound. One study found that pomegranates are far higher in antioxidants than cranberries, blueberries or green tea. The highest concentration (equal to green tea) of natural Ellagic Acid and other Polyphenols neutralizes damage causing Free Radicals. Pomegranate Seed Oil evens skin tone, scavenges free radicals, acts as a natural SPF booster and helps reverse the damage of sun exposure [11, 48].

ARNICA (*Arnica Montana*) [49]

The main parts of the plant used are dried flower heads. The active constituents flavonoid glycosides, thymol and sesquiterpene lactone (helenalin) are present in abundantly in the dried flower heads and are beneficial against harmful UV rays and thus used as sunscreen agent [50].

BETEL NUT (*Areca catechu*) [51]

Main part of the plant which is frequently used are the seeds. The active constituents include Alkaloids - arcane, 0.1%, recline, 0.2%, areca dine, arecolidine, guvacoline, guvacine, isoguvacine; tannin, 15%; red fat, 14%; resin; choline. It has been long believed that the areca seed has a strong radical-scavenging antioxidant benefit [11, 52].

NEEM (*Azadiracta indica*) [53]



Every part of the plant bark, root-bark, young fruit, nut or seed, flowers, leaves, gum and toddy or sap has medicinal applications. It contains alkaloids - nimbin, margosine, nimbinin, nimbidin. Antioxidant activity was found in the extract obtained from neem seeds. Neem oil extracted from the neem plant when used externally was found to have enhanced sunscreen activity [54, 55].

GARLIC (*Allium sativum*) [56]



The part of the plant used for medicinal properties is bulbs. The chemical constituents are alliin, allicin, cycloallin, etc. The key ingredient in garlic is S-allyl cysteine (SAC), which has been proven to protect against oxidation and free radicals. SAC demonstrated radical and hydrogen peroxide scavenging activities. SAC is (S-allyl-L-cysteine) [57].

GRAPE FRUIT (*Vitis vinifera*) [58]



Grape fruit extract is used as an active antioxidant and effective against sunburns. It also *includes* the presence of a carotenoid known as xanthophyll which has a free radical scavenging activity. Grape leaf extract has also been used in after sun lotion due to the presence of procynadins [13, 59, 60].

ROSE (*Rosa damascena*) [61]



The oil extracted from the leaves of rose flower has high amount of phenols which have proven antioxidant activity and are highly recommended use in protection against sunburns. The sunscreen activity of rose oil was found due to the presence of citrenellol and geraniol [62, 63].

LAVENDER (*Lavandula vera*) [64]



Lavandula oil which is obtained from the flowering tips of evergreen shrub has chemical constituent mainly comprising of linalyl acetate, geraniol and cineole. Lavender exhibits higher protective activity against sunburns. The main parts used for the activity are flowers and leaves [65].

ALMOND (*Prunus amygdalus*) [66]



The oil obtained after expression of the ripe seed kernels consists of oleic and linoleic triglycerides. It also contains proteins and carbohydrates. Oil obtained from the kernels is highly recommended in sunscreen preparations due to its preventive action against harmful UV rays [67].

TULSI (*Ocimum sanctum*) [68]



The extracts obtained from the leaf of tulsi plant were found to have enhanced antioxidant action and also acts as a sunscreen agent. The antioxidant or free radical scavenging effect was found due to the polyphenol compounds which are found in the leaf extract [69].

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