Potential of Natural Compounds as Sunscreen Agents

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ABSTRACT
Many skin diseases such as sunburn, pigmentation, wrinkles, dermatitis, urticaria, ageing, skin cancers and immune suppression are due to the extreme exposure to harmful sun radiations. The mere covering of skin through sunglasses, clothes or other external agents is not adequate protection method. Therefore, application of sunscreen is considered as one of the trendiest methods to get rid of the skin aging, sunburn and other related problem arises due to the exposure of ultraviolet radiation (UV) radiations. Sunscreen agents protect from the sun by absorbing the UV and visible sun rays. Herbs have been used in medicines and cosmetics from centuries and their potential to treat different skin diseases, to adorn and improve the skin appearance is well-known. The presented review article is concern with discussion on various plant derived chemicals acting as sunscreen agents such as squalene, peptides, and nucleotides etc and protecting mammalian skin. Herbs and herbal preparations have a high potential due to their antioxidant activity. Antioxidants such as vitamins (Vitamin C, Vitamin E), flavonoids, and phenolic acids play the main role in fighting against free radical species that are the main cause of numerous negative skin changes. Effective botanical antioxidant compounds are widely used in traditional medicine and include tocochromers, flavonoids, phenolic acids, nitrogen containing compounds (indoles, alkaloids, amines, and amino acids), and monoterpenes. Anthocyanin’s, Proanthocyanidin, Quercetin, Anthranilate, Resveratrol, Apigenin, Silymarin, Curcumin, Carotenoids are well known plant derived active chemicals that have potential to absorb radiations. This review covers all essential aspects of potential of herbs as radioprotective agents and its prospects.

Key words: UV radiation, Skin diseases, Skin Cancer, Photoprotection, Phytochemicals, Herbal products, Sunscreen.

INTRODUCTION
Overexposure of sunlight is hazardous to human as it has many detrimental effects on eye, immune system as well as on the skin. There has been records of increase in skin cancer related data as a result of various outdoor activities. People heading towards beach in only their bath suit so due to extra exposure of sun sunburn happens experts also says that we can prevent skin cancer by 80% by means of avoiding the sun or by having the protective gear that can prevent sun exposure. As per WHO recommendation, it is essential to put sun screen of broader spectrum (SPF 15+) in plenty amount after popular outdoor activities like, playing, swimming or exercising. The goal of sunscreen formulation is to block UV rays and increase the protection against it. By not using sunscreen when in the sun can accelerate the skin disease like wrinkles, early aging and skin cancer. Approximately one out of five people in United States develop skin cancer in their lifetime. The major cause of these disease is exposure to UV radiations such as UVa and UVb. UVa rays are responsible for sunburn whereas UVb enter more deeper into tissues that is the main cause of premature aging. Physical barrier just scatter, reflect and block the UV radiation by using various accessories such as goggles, hat and full sleeve clothes. On the other hand the chemical sun blockers absorb the harmful radiations and shield the skin. Sunlight is essential for bodily functions like producing Vitamin D and maintaining your mood but too much exposure of sun can also be harmful. As per the drug and cosmetic act 1940 and the rule in 1945 “cosmetic” means any article intended to be rubbed, poured, sprinkled or sprayed on, or introduced into, or otherwise applied to the human body or any part thereof for cleansing, beautifying, promoting attractiveness, or altering the appearance and includes any article intended for use as a component of cosmetic. A sunscreen contains more than one ingredient some provide protection against UVa while some against UVb. Sunscreen are mainly rated and marketed by the sun protection factor (SPF) that measures the fraction of UV radiations needed to bring about nominal sunburn. More will be the SPF more will be the protection. The SPF can be described as the fraction of UV radiations needed to bring about nominal erythema on skin after application of sunscreen to the amount of energy needed to bring the same effect on skin without application of sunscreen. Earlier the values of SPF in the marketed sun screen were used to be <1, but nowadays the trend is not same.
PHYTO-PHOTOPROTECTION

Phytoconstituents are very much popular now a days in cosmetic products as they not only prevent the exposure of harmful endogenous and exogenous agents but also protect from many skin diseases. Overexposure of sunlight can lead to the skin cancer and photoaging, which results in appearance of fine lines, wrinkles, loose of the elasticity and hyperpigmentation mark can appear. Herbal extract can heal and soft the skin and also provide sunscreen effects. We have selected some phytoconstituent like resveratrol, quercetin, silymarin and Vitamin C that are not only good for skin conditioning but also considered good for the development of herbal cosmetic formulation that can diminish the probability of skin cancer and photoaging process.

Flavonoids

These are the secondary metabolites found in the plants and have potential of blocking harmful radiation by absorbing the sunlight in the ultraviolet region, also have antioxidant property and they modulate several signalling pathways. The presence of flower pigments is a distinguished feature of flavonoid in most of angiosperm families. However, they are not only found in flowers but are also found in all parts of plant. Flavonols are one of the most important categories of flavonoids which carry ketone group and it is also the foundation for proanthocyanidin. It can be categorised in various sections according to the oxidation, the degree of unsaturation and the carbon of the ring C where the ring B is attached. Isoflavones are the flavonoid where ring B is attached at position 3 to the ring C. Neoflavonoids, are linked at to ring B at 4 position of ring C, whereas the compounds where attachment of both the ring occur at 2’4’ position, are classified in various subclasses such as flavones, flavanonols, flavanol, catechin and its derivatives based on structural features of ring as shown in Figure 2. Flavonoids are found in various vegetable, fruit, bark and root of some plants, flower, wine and tea. Flavonoids shows anti-mutagenic, anti-carcinogenic, anti-carcinogenic, antioxidative, anti-inflammatory actions. UV absorption spectrum of flavonoids has two maximum peaks of absorption, one between 240nm and 280nm and the other at 300-500nm so, they can be used in formulations to block UV and UVB radiations. The plant extract of cinnamon and flavonoids is known for its potential to protect early aging caused by various external factors, antioxidant properties, absorption of UV rays, usefulness in cosmetics and action against the free radicals. Quercetin is obtained from oak plant, that acts as natural inhibitors of auxin. Quercetin is a flavon which is classified under six subclasses of flavonoid. The standard IUPAC nomenclature of quercetin is 3, 3,4, 5,7-pentahydroxy-2-phenylchromen-4-one or 3,4,5,7-pentahydroxyflavone, that indicate the presence of hydroxyl group at various positions of quercetin. It lacks the sugar attachment to aglycone part. Physically, it appears as brilliant citron yellow with needle shape crystal, which is highly soluble in alcohols and lipids, insoluble in cold water and very less soluble in hot water. The rich source of quercetin is apple, brassica, berries, grapes, seeds nuts flower, onion, tomatoes, shallots, tea capers, and many bark and leaves. It helps reduce the effects of free radical damage on skin from UV exposure, flavonoids can also provide a non-negligible level of photoprotection in UV, range. Apigenin is found in various fruit like apple, grapes and cherries, found in various herbs (clove, endive and German chamomile), vegetables (beans, leeks, onion, broccoli, celery, parsley) and beverages (wine and tea). Chemo preventive agents protects UV-induced skin cancer and also retard DNA damage in cell free system. Silymarin extract is obtained from oldest herbal plant S. marianum seeds. Silymarin milk thistle is rich constituent of polyphenols. Silymarin is also used in cosmetic and dermatological preparation for its antioxidant's effects. It also has ability to reduce UV and chemical induced damage.

Terpenoids

Terpenoids or isoprenoids are diverse compounds that are composed of isoprene units (five carbon compound) that has various basic skeleton and functional groups. The term "terpene" and "terpenoid" are frequently interchanged. Sometimes "terpenoids" are included in "terpene", and somewhere they are labelled as modified terpene. Leray stated that both of these terms should not be used interchangeably. Terpenes are the chemical constituents that possesses 10-15 carbon and terpenoids are terpenes that are modified by removal of methyl group in place of addition of oxygen to hydrocarbon. Depending upon the number of isoprene units terpenoids are categorised as mono, sesqui, di, tri with 2,3,4, and 6 isoprene unit respectively. Steroids, tocopherols, taxanes, artemisinins, ingenes and cannabinoinds are considered as six main class of terpenoids. Many terpenes have biological activities (against cancer, malaria, viral and bacterial diseases and inflammation). Cinnamate acid and its derivatives are found in plant-based food like, whole grains, vegetables and fruit. 3-phenylprop-2-enolic acid or tinzaparin or 3-phenylacrylic acid are the called as cinnamic acid. Other derivatives of this class are of cinnamyl alcohol, cinnamaldehyde and dihydrocinnamyl alcohol. Its derivatives in cosmetic in UV protection. Provide protection against UV light ranging from minimum photoprotection. It decreases undesirable effects of sunscreen of this class. Xanthin is found in big concentration in several green leaf vegetable, such as broccoli, spinach kale, cabbage and green mustard leaves etc. Zeaxanthin fraction
### Major plants phytoconstituents with sun screening potential.

<table>
<thead>
<tr>
<th>Plant Name</th>
<th>Plant Parts</th>
<th>Major Constituents</th>
<th>Mode of Action</th>
<th>References</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Flavonoids</strong></td>
<td></td>
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<tr>
<td>Black carrot</td>
<td>Root</td>
<td>Anthocyanins-cyanidin, peonidin, pelargonidin.</td>
<td>Anthocyanins is the antioxidant activities and fortification against DNA injury, these composites being capable to detain hazardous free radicals as singlet oxygen ($1O_2$), superoxide radical ($O_2^-$), hydroxyl radical (OH) and hydrogen peroxide (H$_2$O$_2$), chemical groups that direct to lipid peroxidation of cell membranes.</td>
<td>[63]</td>
</tr>
<tr>
<td>Marigold</td>
<td>Flowers</td>
<td>Apigenin</td>
<td>Apigenin effective in the prevention of UVA/UVB-induced skin carcinogenesis.</td>
<td>[64]</td>
</tr>
<tr>
<td>Cumin</td>
<td>Fruit</td>
<td></td>
<td></td>
<td>[23]</td>
</tr>
<tr>
<td>Peppermint</td>
<td>Herbs</td>
<td></td>
<td></td>
<td>[64]</td>
</tr>
</tbody>
</table>
| Green and black tea| Leaves extract | (−)-epigallocatechin-3-gallate (EGCG), (−)-epigallocatechin (EGC), (−)-epicatechin-3-gallate (EGC), and (−)-epicatechin (EC), catechins | 1. Topical green tea applied to human skin provide a photoprotective effect, reduced the number of sunburns cells, protecting epidermal Langerhans cells from UV damage, and reduced the DNA damage that formed after UV radiation.  
2. Black tea to the skin to soothe sunburn  
3. Catechins help prevent and repair skin damage and may even help prevent chemical- and radiation-induced skin cancers. | [65] [38] [66] |
| Grape seed         | Seed extract | oligomeric proanthocyanidins, Catechin, epicatechin, and taxifolin | 1. Grape seed extract in the selected sunscreen lotion resulted in increasing SPF value and had good antioxidant activity.                                                                                     | [67]       |
| Apple barriers     | Fruit extract | Quercetin                                              | 1. Help reduce the effects of free radical damage on cells from UV exposure.                                                                                                                                  | [69]       |
| Milk thistle       | Seed        | Silymarin -flavonoid compound                           | 1. Silymarin can provide substantial protection against different stages of UVB-induced carcinogenesis, possibly via its strong antioxidant properties.  
2. Silymarin reduced UV-induced sunburn cell formation and apoptosis.  
3. Silymarin treatment prevents UVB-induced immune suppression and oxidative stress in vivo | [70] [25] [71] |
<p>| <strong>Terpenoids</strong>     |             |                                                         | All the camphor-derived sunscreens dissipate the photon energy by cis-trans isomerization. However, for Enfacement the quantum yield for this isomerization is only between 0.13-0.3. This low quantum yield means that other photochemical processes are also occurring | [72]       |
| Camphor            | Wood and bark | Enzacamene - 3-Benzylidene camphor - Benzylidene camphor sulfonyc acid Camphor benzalkonium methosulfate - 4-Methylbenzylidene camphor - Poly Acryl amido Methyl Benzylidene camphor |                                                                                                                                                                                                              |            |</p>
<table>
<thead>
<tr>
<th>Plant Name</th>
<th>Part</th>
<th>Phytochemicals</th>
<th>Summary</th>
</tr>
</thead>
</table>
| Green, red and yellow plant | Fruit            | Zeaxanthin, Canthaxanthin and bcarotene. Isoprenoids, lycopene β-carotene, α-tocopherol, and selenium. | 1. The crude extract and the zeaxanthin fraction were incorporated in a gel based sun protective formulation and analysed for the SPF and boot star rating.  
2. Oral administration of lycopene β-carotene, α-tocopherol, and selenium reported decreased UV-induced erythema, lipid peroxidation, and sunburn cell formation. |
| Tabat barito (Ficus deltoid Jack) | Leaves           | Germanicol cinnamate. Glyceryl esters of p-methoxycinnamic acid, 1,3-dipalmitoyl-2-p-methoxycinnamoyl-1,2,3-propanetriol and 1,3-dioctanoyl-2-p-methoxycinnamoyl-1,2,3-propanetriol | 1. Provided protection against UV light, ranging from a minimum protection to ultra.  
2. Increase substantivity and decrease eventual undesirable effects of sunscreens of this class                                                                                     |
| Krameria triandra (Krameria lappacea) | Root extract   | octyl methoxyxycinnamate, 15% neolignans                                        | 1. It absorbs slightly more UV light in the 340-380nm range than the organic sunscreen does  
2. As topical antioxidants/radical scavengers against skin photodamage.  
3. Antioxidant, photoprotective, cytoprotective effect, radical scavenger                                                                 |
| White Willow Bark And Wintergreen Leaves | Bark and leaves | Homomenthyl salicylate (homosalate), ethylhexyl salicylate (octyl salicylate) and trolamine salicylate, sopropylbenzyl salicylate, Triethanolamine salicylate Salicylic acid salts (potassium, sodium and triethanolamine). | 1. They have weak UVB absorbing properties and are generally used in combination with other chemical absorbing sunscreen agents.  
2. Octyl salicylate, are also used to help other UV filters mix into the sunscreen.                                                                                         |
| Tea tree (Melaleuca alternifolia) oil | Leaves          | terpinen-4-ol, 1,8-cineole, alpha-terpineol, and gamma-terpineol.              | It is an effective antiseptic, fungicide, and germicide. It is a popular component of many sunscreen formulations that relieve sunburn by increasing blood flow in capillaries, bringing nutrients to damaging skin                                                                 |
| Walnut (Juglans regia) fresh green shells |                      | juglone (5-hydroxy-1,4-napthoquinone), lawson (2-hydroxy-1,4-napthoquinone), seven phenolic compound identified in walnut husk- ferulic acid, vanillic acid, coumaric acid, syringic acid, myricetin, and juglone. | 1. Aqueous extract has been shown to be particularly effective as a self-tanning sunscreen agent.  
2. Juglone- UV protection properties.  
3. Myricetin with antioxidant properties.                                                                                                                                  |
| Almond (Prunus dulcis) fruit |                      | Phenolic acid                                                                 | The UVB protective property of this plant’s skin extract was tested.                                                                                                                                  |

**Antioxidants**

Amla (Emblica officinalis) Fruit extract 1-O-Galloyl-β-D-glucose (β-glucogallin), β-Glucogallin  
1. Photoprotection efficacy due to its inhibitory effect on ultraviolet radiation.  
2. β-glucogallin can be the active principle which is significantly responsible for the photoprotection efficacy.  
3. Strong antioxidant activities against the UV penetration and anti-aging.  

[23][73][74][75][76][77][78][79]
<table>
<thead>
<tr>
<th>Plant</th>
<th>Part Used</th>
<th>Phytochemicals</th>
<th>Effects</th>
<th>References</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lemon (Citrus limon)</td>
<td>Fruits and seed extract</td>
<td>Ascorbic acid (Vitamin C)</td>
<td>Vitamin C is capable of additive protection against acute UVB damage (sunburn cell formation) when combined with a UVB sunscreen.</td>
<td>[80]</td>
</tr>
<tr>
<td>Orange (Citrus sinensis)</td>
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<tr>
<td>Mango (Mangifera indica)</td>
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<tr>
<td>Red grapes (Vitis vinifera)</td>
<td>Grape skins</td>
<td>Resveratrol stilbene (3,5,4'-trihydroxystilbene) polyphenolic phytoalexin</td>
<td>1. Effects of resveratrol against ultraviolet radiation mediated oxidative stress and cutaneous damages including skin cancer 2. Topical application with resveratrol (both pre- and post-treatment) results in inhibition of UVB-induced tumor incidence and delay in the onset of skin tumorigenesis.</td>
<td>[81], [82], [25]</td>
</tr>
<tr>
<td>Broccoli</td>
<td>Fruit, Rhizomes and Leaf</td>
<td>Retinol (vitamin A) and palmitic acid</td>
<td>1. It can serve as an antioxidant to improve product performance against the aging effects of UV exposure or to enhance the aesthetic qualities of sunscreen. 2. Topical application with resveratrol (both pre- and post-treatment) results in inhibition of UVB-induced tumor incidence and delay in the onset of skin tumorigenesis.</td>
<td>[83], [84], [85]</td>
</tr>
<tr>
<td>Cantaloupe Squash</td>
<td>Seed, flower, fruit</td>
<td>(α-tocopherol), tocotrienol, linoleic acid</td>
<td>1. Alpha-tocopherol and tocotrienol—effectively reduce skin roughness, the length of facial lines, and the depth of wrinkles. 2. Vitamin E is a free radical scavenger and an emollient too. 3. Tocopherols and phenolics, which account for 59% of the antioxidant effects.</td>
<td>[86], [23], [87], [88]</td>
</tr>
<tr>
<td>Triticum vulgare (wheat germ), Helianthus annuus (sunflower), Sesamum indicum (sesame) oils</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cucumber (Cucumis sativus)</td>
<td>Fruits</td>
<td>Lycopene</td>
<td>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)</td>
<td>[89-91]</td>
</tr>
<tr>
<td>Tomato (Solanum lycopersicum)</td>
<td>Fruit extract</td>
<td>Lycopene</td>
<td>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.</td>
<td>[92], [93]</td>
</tr>
<tr>
<td>Pomegranate (Punica granatum)</td>
<td>Fruits</td>
<td>Ellagitannins and anthocyanins.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cucumber (Cucumis sativus)</td>
<td>fruits</td>
<td>ascorbic acid (vitamin C) and caffeic acid,</td>
<td>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.</td>
<td>[94], [95]</td>
</tr>
<tr>
<td>Indian Beech Tree</td>
<td>Leaves extract</td>
<td>antioxidants</td>
<td>The absorption spectra of various solvent extracts of this plant were measured using UV visible Spectrophotomete. The aqueous and methanol extracts were found to be highly effective in UVB region and moderately effective in UVA region.</td>
<td>[96]</td>
</tr>
<tr>
<td>African tulip tree (Spathodea campanulata)</td>
<td>bark</td>
<td>antioxidants</td>
<td>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</td>
<td>[97]</td>
</tr>
<tr>
<td><strong>Amino acids</strong></td>
<td><strong>Lipids</strong></td>
<td><strong>Glycosides</strong></td>
<td><strong>Resins</strong></td>
<td><strong>Other</strong></td>
</tr>
<tr>
<td>----------------</td>
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</tr>
<tr>
<td><strong>Aloe Vera</strong> Leaves</td>
<td><strong>Avocado (Persea Americana)</strong> Fruit</td>
<td><strong>Licorice (Glycyrrhiza glabra)</strong> Root extract</td>
<td><strong>Turmeric (Curcuma longa)</strong> Rhizome</td>
<td><strong>Jasmine (Jasminum officinale)</strong> flowers</td>
</tr>
<tr>
<td>AMINO ACID-Leucine, Isoleucine, Lysine, Methionine, Phenylalanin, Threonine, Valin, Tryptophan. ANTHRAQUINONES-Chrysophanoic Acid, Emodine. ENZYME-Catalase.</td>
<td>Linoleic acid, Oleic acid, Palmitic acid, Omega-3 fatty acids and Vitamins A, D, and Beta Carotene, Lecithin.</td>
<td>Methyl and methyl anthranilate</td>
<td>Curcumin (diferuloylmethane), polyphenolic compounds, curcuminoids, demethoxycurcumin</td>
<td>Methyl and methyl anthranilate</td>
</tr>
<tr>
<td>Aloe Vera is a unique and effective moisturizer, and work as a healing agent for the skin.</td>
<td>Avocado oil is very easily absorbed by the human skin, keeping it firm and smooth.</td>
<td>The Anthranilate are considered to be a photostable (non-degradable upon exposure to UV) class of sunscreens due to the intramolecular hydrogen bonding facilitated by the ortho position of the NH$_2$ group with respect to the ester substituent</td>
<td>1. Curcumin can prevent UV irradiation-induced apoptotic changes in human epidermoid carcinoma A431 cells. 2. Curcumin possesses anti-inflammatory, antitumoral, and antioxidant properties.</td>
<td>The Anthranilate are considered to be a photostable (non-degradable upon exposure to UV) class of sunscreens due to the intramolecular hydrogen bonding facilitated by the ortho position of the NH$_2$ group with respect to the ester substituent</td>
</tr>
<tr>
<td><strong>Caprylhydroxamic acid</strong> Liquid</td>
<td><strong>Evening primrose oil (Oenothera biennis)</strong> seed</td>
<td><strong>Soybeans (Glycine max)</strong> nuts</td>
<td></td>
<td><strong>Saffron (Crocus sativus)</strong> powder</td>
</tr>
<tr>
<td>Caprylhydroxamic Acid or Octano-hydroxamic Acid</td>
<td>gamma-linolenic acid (GLA)</td>
<td>fatty acids, protein, lecithin,</td>
<td></td>
<td>homosalate</td>
</tr>
<tr>
<td>1. It’s a gentle preservative that ensures product safety and longevity use. 2. Caprylhydroxamic acid in combination with caprylyl glycol and glycerin to provide gentle, broad spectrum antimicrobial preservation.</td>
<td>1. Evening primrose oil discourages dry skin and premature aging of the skin 2. It soothes skin problems and inflammation.</td>
<td>Used topically on the skin, soybean oil is a cost-effective moisturizer compared to other oils and has a natural SPF of 10</td>
<td></td>
<td>Saffron can be used as a natural UV absorbing agent</td>
</tr>
<tr>
<td><strong>Porphyra (Bangiales, Rhodophyta)</strong> Edible seaweed</td>
<td><strong>Borage (Borago officinalis)</strong> Seed</td>
<td><strong>Glycosides</strong></td>
<td><strong>Resins</strong></td>
<td></td>
</tr>
<tr>
<td>Vitamin B12, Amino-acid</td>
<td>Borage oil, gamma-linoleic acid (GLA)</td>
<td>Methyl and methyl anthranilate</td>
<td>Curcumin (diferuloylmethane), polyphenolic compounds, curcuminoids, demethoxycurcumin</td>
<td></td>
</tr>
<tr>
<td>Daily UV protective care - Sun care - Anti-photo-aging care.</td>
<td>1. Borage oil stimulates skin cell activity and encourages skin regeneration. 2. Borage penetrates the skin easily and benefits all types of skin, particularly dry, dehydrated, mature, or prematurely aging skin 3. Treat all kinds of skin inflammation including Eczema, dermatitis, psoriasis and rosacea.</td>
<td>The Anthranilate are considered to be a photostable (non-degradable upon exposure to UV) class of sunscreens due to the intramolecular hydrogen bonding facilitated by the ortho position of the NH$_2$ group with respect to the ester substituent</td>
<td></td>
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</table>
and the crude extract were incorporated in a gel-based sun protective formulation and analysed for the SPF. Oral administration of selenium, alpha-tocopherol, lycopene and β carotene has demonstrated reduced lipid peroxidation, erythema and formation of sunburn cell on induction by UV rays.[48] Carotenoids like zeaxanthin/ b- carotene/ canthaxanthin extracted from the thermotolerant genera synecochystis, pevalekii is screened for production of UV protective compound and their role in skin protection.[49] Juglone are made from fresh shell of English walnut, Juglans regia. Juglone is predominantly used as a self-tanning agent apart from its sunscreen potential and have antioxidant property.[50] The chemical structure of terpenoids containing compounds as shown in Figure 3.

Antioxidants

Many phytochemical sunscreen acts as antioxidants including Vitamin C and E, green tea polyphenols and silymarin. Vitamin C (as shown in Figure 4) protects against UV damage, which result in sunburn and erythema. Vitamin E also has many protective action like decreasing immunosuppression, photoaging and photo carcinogenesis.[9] Amla is a fruit extract (1-O-Galloyl-β-D-glucose (β-Glucogallin), β-Glucogallin) have photoprotection efficacy due to its inhibitory effect on ultraviolet radiation.[51] It contains β-glucogallin so significantly responsible for the photoprotection efficacy and have strong antioxidant activities against the UV penetration and anti-aging.[51] Resveratrol- Belongs to qualify polyphenolic compounds. It is fat soluble and shows anti- mutagen and antioxidant properties and also shows anti-aging properties. It is mainly found in wine, grape skin, berries juice and peanut products. It is very abundant in the roots of weed Polygonum cuspidatum and also in leaves of Veratrum grandiflorum. Resveratrol also delay the skin tumorigenesis and inhibit the UVB induced tumour incidence. It also induces the human promyelocytic leukemia cell differentiation.[23]

Ascorbic acid- this is also known as vitamin C. Ascorbic acid helps in adding protection against acute UVB damage. So it is also used in sunscreen for better protection and also sold as a dietary supplement. Also function as an antioxidant. Some salt like ascorbate salt and sodium ascorbate are need in dietary supplement. Deficiency of vitamin C can lead to impaired collagen synthesis.[52]

Lycopene - It is a plant nutrient with antioxidant properties mainly found in red and pink fruits like tomatoes, pink grapefruit, watermelons. Lycopene linked to heart healthy properties. Test tube study showed that lycopene slows down the growth of breast cancer by limiting tumor growth.[53]

Lipids

Lipids are a various and prominent group of natural biological compounds and also found in animal, plants and micro organisms. it is present in cosmetic formulation to be applied to skin or protect the skin and enhance the body appearance, create a protection barriers on the skin from harmful external substance and also help to it keep soft and hydrated.[55] The major natural ingredients present are lipids plant oil and fatty acids. Plant oil such as Avocado oil (Persea americana), Borage oil (Borago officinalis), Evening primrose oil (Oenothera biennis), Soybeans oil (Glycine max). Avocado oil carry main major constituents like Linoleic acid, Oleic acid, Palmitic acid, Omega-3 fatty acids and Vitamins A, D, and Beta Carotene.[66] Lecithin. The action of Avocado oil herbal formulation is that it is very easily absorbed by the human skin, keeping it firm and smooth and also avocados may help to protect the skin from harmful UV radiation. Borage oil carry main constituents that is gamma-linoleic acid (GLA). Borage oil has various application in skin formulations. It boosts regeneration of skin and also rouses cell activity. It deeply enters to the skin and therefore helpful for preventing inflammation including Eczema, dermatitis, psoriasis and rosacea in different skin types including, dehydrated, dry, prematurely aging and mature skin. Evening primrose oil also contain GLA as active constituent. [23] Evening primrose oil used in the herbal formulation as it diminishes
and its main derivatives of 9-10 anthraquinone include drug like antimalarial, glycosides are used in the production of hydrogen peroxide and compound based on the anthraquinone skeleton. Mainly anthraquinone Anthraquinone Glycosides: There are naturally occurring phenolic glycosides such as tryptophan and its analogues. porphyrins, haemoglobin, eumelanin flavin and aromatic amino acids and photo-sensitisers such as purines, and pyrimidines, retinoic acid, photo screen (pheomelanin, melatonin and some aromatic amino acids) have cutaneous photochemical barrier that in human comprises of the presence of active pharmacophores such as antioxidants, lipids, enzymes etc. Therefore, present study reveals the potential natural plant constituents and their effects against UV induced sun burns, cancers etc. The discovery of newer naturally derived sunscreens requires further intensive work by researchers. Therefore, the present paper may be helpful for the researchers and scientists to discover and formulate newer plant derived chemicals with sun protection activity with a target of minimum cost and high efficacy.

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CONFLICT OF INTEREST

The authors declare no conflict of interest, financial or otherwise.

ABBREVIATIONS


REFERENCES

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