IJNRD.ORG ISSN : 2456-4184
INTERNATIONAL JOURNAL OF NOVEL RESEARCH AND DEVELOPMENT (IJNRD) | IJNRD.ORG
An International Open Access, Peer-reviewed, Refereed Journal

Phytocontituents As Photoprotective Novel Cosmetic Formulation

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Abstract

Phytoconstituents are gaining appeal as ingredients in cosmetic formulations as they can protect the skin against exogenous and endogenous toxic substances and can help treat various skin disorders. Exposure of skin to sunlight and other atmospheric circumstances induces the creation of reactive oxygen species, which can react with DNA, proteins, and fatty acids, producing oxidative damage and weakening of antioxidant system. Various synthetic agents have been used as photoprotectives but they have limited use because of their potential toxicity in humans and their ability to interfere only in selected pathways of multistage process of carcinogenesis. A few phytoconstituents that have been identified as photoprotective include curcumin, resveratrol, tea polyphenols, silymarin, quercetin, and ascorbic acid. We have also talked about the steps that need to be taken in order to develop herbal cosmetic formulations that may slow down the aging process and prevent skin cancer.

Keywords: Photoprotectives, Phytoconstituent, Evaluation.

Introduction

Long exposure of UV radiation raises the risk of skin cancer including basal cell and squamous cell carcinoma as well as malignant melanoma. There are also many particular disorders like phototoxic or photoallergic reactions, autoimmune diseases including lupus erythematous, idiopathic photodermatosis and kinds of skin malignancies which are initiated or exacerbated by UV radiation exposure. Solar UVR is classified into three categories UV-C (200-280 nm), UV-B (280-320 nm) and UV-A (320-400 nm). UV-C is the most harmful to biology, but the ozone layer blocks it out. Skin cancer is currently caused by UV-B radiation and, to a lesser extent, UV-A radiation.[1] Few examples are tea polyphenols, curcumin, silymarin, garlic components, apigenin, resveratrol, ginkgo biloba, beta- carotene, ascorbic acid etc. Compounds that can protect against UV- A and UV- B radiations both potentially be effective photochemoprotective agents.[2] Naturally occurring antioxidants such alpha carotene, ascorbic acids, flavones, flavanone, have potential to donate electrons and prevents free radical chain reactions and also demonstrated broad spectrum UV absorption.[3,4] It was observed that interaction of botanical extracts (bioflavonoids) and vitamins create synergistic photoprotective effects in avoiding enhanced erythema, transepidermal water loss and sunburn cell formation.[5]

Important Photoprotective Phytoconstituents

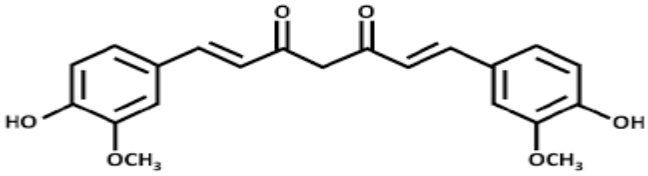
A few phytoconstituents have been chosen, and their details are provided,

- **Curcumin**

Known by the name diferuloylmethane, curcumin (1,7-bis(4-hydroxy-3-methoxyphenyl)-1,6-heptadiene-3,5-dione) is the primary naturally occurring polyphenol present in the rhizome of Curcuma longa, or turmeric, as well as other Curcuma spp.[6] Because of its anti-inflammatory, anti-mutagenic, antibacterial[8, 9], antioxidant[7], and anticancer qualities, curcuma longa has long been utilized as a medicinal herb in Asian nations[10,11]. A polyphenol's numerous health advantages have been supported by evidence that it targets several signaling molecules and exhibits cellular action.[12] Research has demonstrated its potential benefits for inflammatory disorders[13], metabolic syndrome[14], pain [15], and the treatment of degenerative and inflammatory eye conditions.[16, 17]

Benefits

1. Encourages skin that is vibrant and youthful.
2. Curcumin prevents wrinkles and fine lines while promoting soft, smooth, luminous skin.
3. Curcumin promotes the health of brain tissue and the best possible general cognitive performance.
4. Promotes bone and joint health.
5. It has been demonstrated that curcumin reduces pain and enhances the anti-inflammatory response.
6. Curcumin promotes healthy cholesterol levels and heart health.



Curcumin

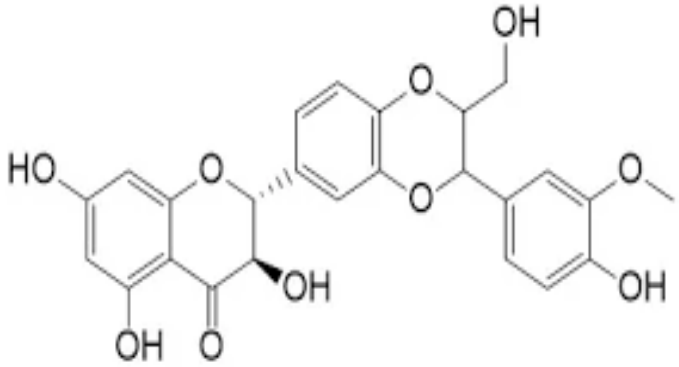
- **Silymarin**

Silymarin, alternatively called silibinin, is a milk thistle-derived polyphenolic flavonoid. Three phytochemicals make up silymarin: silybin, silidianin, and silicristin. The most potent phytochemical, silybin, is mostly to blame for the supposed health advantages of silymarin. Various analytical techniques have been published for its detection, such as UV spectrophotometry, potentiometric titration, diffuse reflectance fourier transform infrared spectroscopy, TLC, HPTLC, and high-performance liquid chromatography (HPLC). There aren't many spectrophotometric techniques available for silymarin assays. The theory behind these techniques is that the drug forms a colored complex with 2,4-dinitrophenyl hydrazine when tetramethylamine hydroxide is present, and when it reacts with diazotized sulfanilic acid in an alkaline medium, an orange-red colored chromogen is formed. At 510 nm, 1,10-phenanthroline was used to determine the amount of oxidation by Fe(III) and reduced Fe(II). Folin-Ciocalteau reagent was then used to produce a blue-colored complex in the presence of NaOH, and a subsequent determination was made at 740 nm. It has also been identified in medication formulations by measuring a drop in absorbance at 530 nm following its oxidation with potassium permanganate at a neutral pH.[18]

Benefits

1. Silymarin is a pigmentation reducer.
2. It offers immediate outcomes.

3. It makes your skin's pores clear.
4. It lessens acne and outbreaks.
5. Your skin is hydrated and moisturized with silymarin.



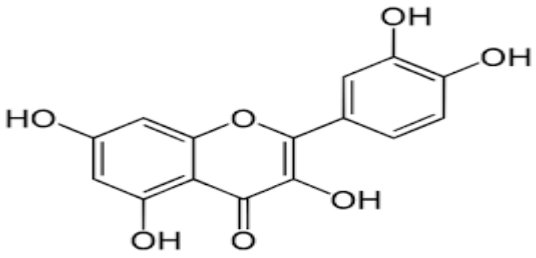
Silymarin

- **Quercetin**

One of the dietary flavonoids that has been investigated the most is quercetin, which is widely found in a wide range of fruits, vegetables, tea, nuts, seeds, and red wine.[19-21] Excellent antioxidant that scavenges free radicals is quercetin.[22]

Benefits

1. Quercetin combats skin allergies.
2. Quercetin is an anti-inflammatory agent.
3. It's an anti-aging ingredient.
4. It is applied for skin lightening.
5. It is an agent that fights acne.



Quercetin

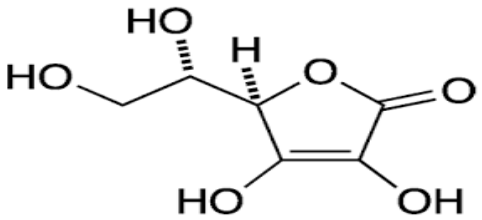
- **Ascorbic acid**

In human tissue, ascorbic acid, also known as vitamin C, is the most prevalent and usually water-soluble nonenzymic antioxidant.[23, 24] This vitamin is produced in vivo by a large proportion of plants and animals from

glucose. However, because humans and some other vertebrates lack the enzyme L-glucono-gamma lactone oxidase, ascorbic acid cannot be produced and must be acquired from diet.[25, 26]

Benefits

1. Permeates the skin cell deeply and repairs it.
2. Increases moisture and hydrates
3. Reduce fine wrinkles and skin discoloration.
4. It clears up acne.



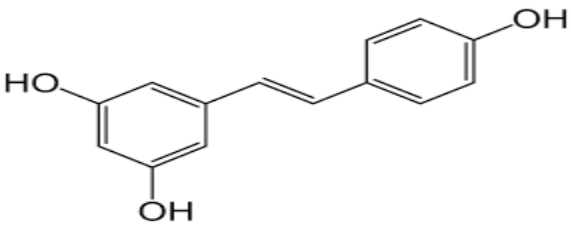
Ascorbic acid

- **Resveratrol**

Resveratrol is a member of the stilbenes class of polyphenolic chemicals, which is mostly present in the root of Polygonum cuspidatum Sieb. et Zucc (Japanese knotweed) and the skins of red grapes. Compound resveratrol is fat soluble and exists in both trans and cis forms. Numerous plants and fruits, such as red grapes, eucalyptus, spruce, blueberries, mulberries, peanuts, and giant knotweed, naturally contain resveratrol, a polyphenolic phytoalexin. And red wine has a lot of it in it. The amount of resveratrol in the grape juice increases with the length of time it is fermented with the grape skins. A potent antioxidant with potent anti-inflammatory and anti-proliferative qualities is resveratrol.[27]

Benefits

1. lessens aging's obvious symptoms.
2. Guards against environmental harm from the sun and pollution.
3. Reduce skin irritation and redness.
4. Reduces dryness by displaying skin moisture.
5. Make skin feel smoother.



Resveratrol

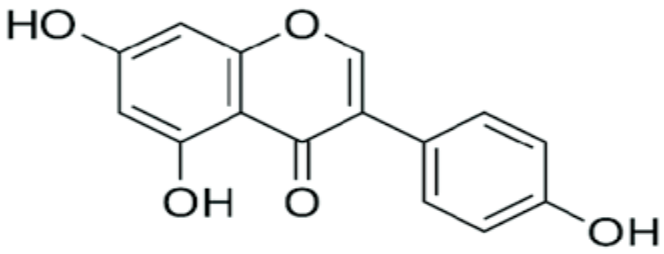
- **Genistein**

The aglycone (without sugar component) of the glycoside genistein is called genistein. Genistein must be liberated from genistein in order to begin acting. Peapods, other legumes, and soya beans are the primary providers of genistein. Certain other legumes, such chickpeas, have trace quantities of genistein. One isoflavone that belongs to the flavonoid group is genistein. Genistein is a phytoestrogen as well because of its structural resemblance to estrogen's. It has antioxidant and phytoestrogen properties. Topical application of genistein and its gastrointestinal

metabolites, including equol, isoequol, and dehydroequol, to the skin of hairless mice significantly reduced the inflammatory edema reaction and suppressed the formation of hydrogen peroxide (H2O2) generated by UV-B light.[28]

Benefits

1. Diminishing the visibility of wrinkles.
2. Aiding in the defense of skin against sun damage.



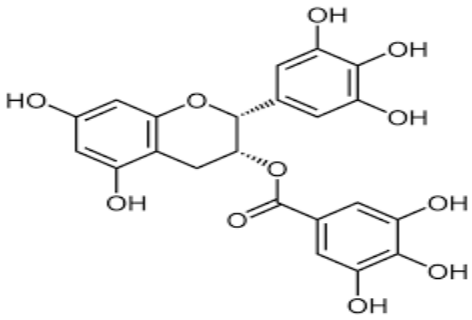
Genistein

- **Green tea extract**

Four catechin derivatives, primarily epicatechin, epigallocatechin, epicatequinagalato, and epigallocatechin-3-gallate (EGCG), are found in green tea (GT) extracts. Because of these compounds' anti-inflammatory, anti-cancer, and antioxidant properties, research has been done on them [30]. Good skin penetration and retention are demonstrated by the green tea polyphenols used into cosmetic compositions. These characteristics, which include the prevention of acute effects from UVB radiation exposure, the reduction of inflammation and, as a result, erythema and immune suppression from sun radiation, may improve skin performance.[29,31]

Benefits

1. Offers protection from skin cancer.
2. Its skin-purifying qualities contribute to a clearer, more radiant appearance for your face.
3. Prevents early aging.
4. Diminishes irritation and redness.
5. It clears up acne.
6. Gives skin moisture.



Green tea extract

Herbal Photoprotective Formulations

The purpose of the study was to assess the antioxidant properties of quercetin and its nanoparticles and to create quercetin-loaded nanoparticles (QUEN) using a nanoprecipitation process using polyvinyl alcohol and Eudragit E (EE) as carriers. When comparing the release of the drug from the QUEN to the pure drug, it was 74 times higher. Furthermore, the antioxidant activity of QUEN was found to be superior to that of pure quercetin in terms of scavenging DPPH (2,2-Diphenyl-1-Picrylhydrazyl), preventing superoxide production, scavenging superoxide anion, and preventing lipid peroxidation.[32]

Based on quercetin's solubility in various oils, the formulation for the quercetin self-emulsified was improved, and the pseudoternary phase diagram was used to assess the self-microemulsified effectiveness of different emulsifier and coemulsifier combinations.[33] The self-emulsified system greatly increases quercetin's solubility, and the formulation is stable and simple to make. Measuring the antioxidant activity is an effective way to assess quercetin skin retention with minimal interference from tissue products. Casagrande et al. took quercetin-loaded formulations of non-ionic emulsion with high lipid content and anionic emulsion with low lipid content and found that quercetin remains functionally stable in formulations. Moreover, these findings imply that topical active solutions containing quercetin could be employed to manage UV-B-mediated oxidative skin damage.[34] In their innovation, Martelli et al. employed curcumin at concentrations ranging from 0.0005 to 10% of the total composition weight for pharmaceutic-dermatologic or cosmetic applications, and they discovered that it was appropriate for preserving skin cells and empowering them to produce skin regeneration.[35]

To investigate resveratrol's physicochemical properties and cardiovascular protective effects, the primary active polyphenol in red wine was added to several emulsion and liposome combinations. It was determined that resveratrol's therapeutic and preventive effects might be effectively enhanced by encapsulating using emulsion-liposome blends.[47]

It was explored if liposomal inclusion of resveratrol, a polyphenol with potent antioxidant and free-radical scavenging characteristics, could enhance its effects on cell proliferation and photoprotection. It is noteworthy that liposomes mitigated the cytotoxicity of resveratrol at high concentrations up to 100 µm avoiding its rapid and widespread intracellular dispersion. Additionally, resveratrol was better able to promote cell proliferation and endurance in UV-B-induced stress conditions.[48]

Sr.no.	Natural Photoprotective Agents	Source/Family	Components	Action/Uses
1.	Tea	Green, black and oolong teas	Catechin, gallocatechin, gallic acid, kaempferol, myricintin	Potent antioxidant and can scavenge ROS
2.	Curcumin	Root of Curcuma longa Zingiberacea	Curcumin (diferuloylmethane)	Antioxidant, anti-inflammatory
3.	Genistein	Soy, red clover, ginkgo biloba, Greek oregano and Greek sage	Genistein	Antioxidant and anticarcinogenic
4.	Apigenin	Vascular plants	5,7,4–trihydroxyflavone	Anticarcinogenic
5.	L-ascorbic acid	Most fruits and vegetables	L-ascorbic acid	Antioxidant

Herbal Constituents Used as Photoprotectives[49, 50]

Biological studies

- **Lipid damage determination**

UV-R causes ROS to be produced, which damages several parts of the skin, including cholesterol and unsaturated free fatty acids through oxidative destruction. It has been noted that UV exposure lowers the mouse skin's temperature at which lipids melt, and that using sunscreen before UV radiation might lessen this epidermal damage.

- **Quantification of UV-induced DNA damage**

The test formulations were administered to volunteers twice a day in order to determine whether use of the formulation shows a protective effect on DNA damage. Suction blister epidermis was used to isolate epidermal keratinocytes, which were then embedded in low-gelling agarose gels in order to measure DNA damage using single-cell gel electrophoresis (Comet assay).[36]

Histologic studies

These investigations involve counting sunburned cells, determining edema, determining wrinkles, and determining epidermal cell turnover. Accelerated epidermal turnover is connected with a decrease in corneocyte size. D-Squame sheet image analysis is used to make the determination.[37] An acute biological reaction to UV-R is inflammation. Skin blood vessel vasodilatation causes erythema, or reddening, and edema, or swelling. Since the therapy lessens the edema, it also serves as a criterion for evaluating photoprotectives. The difference in skinfold thickness between the pre- and post-UV exposure data is used to compute edema. In order to assess facial wrinkles in the crow's feet region, phase shift rapid in vivo measurement of human skin phase induction PRIMOS is used in in vivo topometry. An established and popular technique for measuring the impact on skin wrinkles is the PRIMOS system.[38, 39]

Evaluation Parameters

- **Morphological studies**

The degree of skin barrier penetration varies with particle size, with smaller particles having a higher probability of penetrating the skin deeper than bigger ones.[40] Finding incompatibilities between the formulation's active ingredients and excipients is made easier with the aid of differential scanning calorimetry.[41]

- **In vitro drug release**

Using the dialysis procedure at room temperature, drug release is monitored. An aliquot of each formulation (0.1 ml) is placed in a dialysis tube (molecular weight cutoff dialysis membrane: 12,000–14,000 Mw) and securely sealed after reconstituting the freeze-dried formulation in distilled water/PBS. To maintain sink condition, the tube is submerged in 200 ml of PBS (pH 7.4) release medium and shaken at 300 rpm using a magnetic stirrer.

For 24 hours, samples (0.5 ml) are obtained at prearranged intervals and replaced with an equivalent volume of brand-new medium. Without additional treatment, the drug's concentration is ascertained by UV or HPLC following the proper dilution with acetonitrile.[42]

- **In vitro sun protection factor**

Sun Protection Factor (SPF) is the ratio of UV doses that are protected to those that are not. By monitoring the transmittance after a product film is passed through, the in vitro approach calculates the amount of radiation that has been reduced. Measuring the spectral transmittance at UV wavelengths between 280 and 400 nm is the most widely used in vitro method.[43, 44]

- **In vitro skin permeation studies**

High medication levels in the skin are necessary to improve the efficacy of dermatological treatments. In comparison to typical gels, a larger amount of medication stayed localized in the skin in an experiment involving nanoparticle dispersion, with less entering the receptor compartment. Solid lipid nanoparticles are one type of new colloidal particulate drug carrier that may be able to achieve a drug localizing action in the skin. Due to its submicron size, this colloidal carrier facilitates therapeutic targeting to the skin by improving drug penetration into the skin. Additionally, due to its lipoidal form, the penetrated drug concentrates in the skin and stays localized for an extended duration.[45]

- **In vivo skin hydration studies**

The chosen formulation's skin-hydrating properties are examined in vivo and contrasted with those of the traditional gel. The female albino rats' shaved skin received the topical preparations. The animals were humanely killed after twenty-four hours, and the skin was removed, cut vertically using a microtome, and stained with hematoxylin and eosin. When the formulation is applied to the skin in a way that covers its surface, it decreases transepidermal water loss (TEWL) and water evaporation, increasing the skin's moisture content and thickening the stratum corneum. The higher medication penetration into the skin is also caused by the greater skin hydration.[46]

- **In vitro occlusion studies**

The occlusion factor determines the occlusivity of formulations. The initial research was done by de Vringer.[36] The in vitro model is a beaker of water with filter paper covering it; 200 mg of the formulation is dispersed over an 18.8 cm2 filter surface; a beaker with filter paper but no formulation is kept as a reference control. In comparison to the reference, there is no occlusion impact if the occlusion factor is zero. One hundred is the maximum occlusion factor.

- **Stability studies**

After being flushed with nitrogen, the formulations are sealed in vials (10 mL capacity) and stored for varying lengths of time (10, 20, and 30 days) at 4 and 25°C. By tracking the vesicles' size, shape, and residual drug content over time, the formulations' stability is evaluated.[42]

Conclusion

Many botanical compounds have been shown to be anti-mutagenic, anti-carcinogenic, and nontoxic. They also have the ability to exert striking inhibitory effects on a plethora of cellular events at various stages of carcinogenesis. As a result, there is a need for more research utilizing these phytoconstituents to establish more effective formulations. There are a sufficient number of phytoprotective phytoconstituents, which could be an important part of photoprotective formulations. Since there are numerous pathways that contribute to the development of photocarcinogenesis, combining sunscreen with a blend of botanical antioxidants that function through different mechanisms may also be a useful strategy for lowering UV-generated ROS-mediated photodamage, immune suppression, and skin cancer in people. Using plant extracts in conjunction with additional research into innovative delivery methods will be a successful strategy in the fight against photocarcinogenesis. The creation of herbal photoprotective formulations that are stable, effective, and have a longer half-life could benefit from this article.

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