A Review On Sunscreen

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Abstract- *Sunburn and other skin conditions related to extended exposure to ultraviolet (UV) light have been proven to occur. Through their capacity to absorb, reflect, and scatter UV, sunscreens have reportedly been shown to be helpful in lowering the prevalence of skin problems (sunburn, skin ageing, and immunosuppression). In particular, these products have been enhanced with a number of outstanding qualities to safeguard against the harmful effects of both UVB and UVA radiation. But using sunscreen has its drawbacks, such as the potential to cause photoallergic dermatitis, environmental pollution, and a lack of vitamin D synthesis. In order to improve sun protection and prevent sunscreen side effects, consumers need apply the right products efficiently.*
Keratinocytes are negatively impacted by UVB radiation exposure because it damages their DNA, which might eventually result in malignant transformation. Keratinocytes suffer apoptosis in the absence of adequate repair, giving rise to distinctive "sunburn cells." Sunscreen is a chemical that shields the skin from too much exposure to the sun's UV rays. Due to its capacity to prevent UV-induced sunburns, sunscreen usage is frequently advised for sun protection (the sun protection factor –SPF). It lessens the damaging effects of the sun, including skin cancer and premature ageing of the skin, in addition to helping to avoid sunburn. They are frequently tested on people, and their capacity to shield the skin from the sun is indicated by the sun protection factor (SPF) that is given to them.Sunscreens come in a variety of forms, including cream, lotion, gel, stick, spray, and lip balm. They can only be used outside. A review of organic sunscreen ingredients has been made.

Many medical professionals have promoted the use of sunscreen products as a way to lessen skin damage caused by ultraviolet radiation (UVR) from sunshine. Given the constant push to promote the use of sunscreen products, it is important to comprehend the effectiveness and safety of these products.

Keywords- Sunscreen, History, Classification, Natural Sunscreen Oils, Formulation of sunscreen cream, New developments.

I. INTRODUCTION

UV, visible light, and IR rays are all types of solar radiation that reach the earth's surface [1]. All electromagnetic radiation has a spectrum that ranges in wavelength from 100 nm to 1 mm, with UV radiation having a shorter wavelength (200–400 nm) than visible light (400–740 nm) and IR (760–1,000,000 nm). About 10% of the sun's total light output is UV radiation [2]. Three recommended ranges are separated into the broad spectrum of UV radiation (UVA, UVB, and UVC). There, UVB wavelength is in the intermediate range (280-320 nm), UVC wavelength is in the short range (100-280 nm), and UVA has the longest wavelength (320-400 nm) but the lowest energy photon [2].The usage of sunscreens helps the body's defensive mechanisms fight off dangerous UV rays from the sun. Its operation depends on its capacity to either absorb, reflect, or scatter solar radiation. The Sun protection factor (SPF) of a sunscreen is determined by comparing the time required to create sunburn on skin protected by sunscreen to the time required to cause sunburn on skin that is not protected [3]. The effectiveness of sunscreens depends on their capacity to prevent chemopreventive activity and UV-induced sunburns [4]. Sun exposure's UVR? is a causal factor in both acute and chronic skin damage, including skin malignancies [5].It has been proposed that sun exposure may actually be prolonged because users believe they are protected and will therefore spend longer time in the sun because sunscreens prevent sunburn and their usage is encouraged. This possible outcome brings up a number of related issues. For instance, use of such products alters the UVR spectrum to which the skin is exposed because most sunscreens are largely UVB (290-320 nm) and, in some circumstances, short wavelength UVAII (320-340 nm) filters. Consequently, the dose of long-wavelength UVR, 340 nm and higher, would increase if behaviour is influenced by sunscreen use leading to prolonged periods of sun exposure.The threshold or dose response for UVR-induced effects on other endpoints like immunosuppression or DNA damage are also poorly understood, despite the fact that sunscreens protect sunburn. Finally, concerns have been expressed about sunscreens' long-term safety, particularly when UVR is present, as they are becoming more common and accessible. The goal of this analysis is to address these concerns, whenever possible, with concrete information and go over potential improvements for sunscreen products. In order to better understand the complexity of UVR and how it affects skin, it is important to look at some fundamental ideas. Following a discussion of how UVR affects skin that is not protected, the implications of adding sunscreen to this complex interplay will be examined[5].

History:

Early synthetic sunscreens were first used in 1928. The first major commercial product was brought to market in 1936, introduced by the founder of L'Oreal, French chemist Eugène Schueller. The earliest form of sunscreen was created by Franz Greiter in 1938 and then Benjamin Green in 1944 who used a mixture of cocoa butter and red veterinary petroleum to protect his skin from the sun. Shortly afterwards, Franz Greiter branded his formula Piz Buin while Mr. Green marketed his as Coppertone Suntan Cream. In the United States, one of the first sunscreen products to become popular was invented for the military by Florida airman and pharmacist Benjamin Green in 1944. This came about because of the hazards of sun overexposure to soldiers in the Pacific tropics at the height of World War II(7,8) .

SPF, or Sun Protection Factor, is another word attributed to Franz Grieter. Greiter was climbing a mountain range in the Appalachian Mountains when the harsh UV rays scorched him to death (9). Later, more research was done on the connection between UV light and skin ageing and cancer, such as through Albert Kligman's formulation of the photoageing theory in 1986 or the WHO study on the connection between tanning and skin cancer development in 2007. In the past, people used clothing, scarves, and shade to protect their skin from the sun (10). However, the practise of putting substances on the skin to provide additional protection dates back thousands of years.The skin from sun damage was protected by a range of plant compounds in ancient cultures. Regardless of skin tone, health professionals advise using sunscreen with an SPF of at least 30. Dark-skinned people won't burn as quickly, but they will still burn and are still vulnerable to cancer and UV damage like wrinkles and sun spots(11].

Classification:

A. Inorganic (physical blockers) These are particles that scatter and reflect UV rays back to the environment. They act as a physical barrier to indent ultraviolet and UV light. The two primary inorganic UV filters are Zinc oxide (ZnO) and titanium dioxide (TiO2) white particles which used in the cosmetic and pharmaceutical industries. The current agents are ZnO, TiO2, calamine, ichthammol, talc, and red veterinary petrolatum. Although they are generally less toxic, more stable, and safer for human than those of organic ingredients, they are visible due to white pigment residues left on the skin and can stain clothes(12,13) .Organic sunscreens have been the mainstay of sunscreen formulation for decades and, although inorganic sunscreens are gaining in popularity, organic sunscreens are still used in greater amounts. Organic sunscreens are often classified as derivatives of

(1) anthranilates,
(2) benzophenones,
(3) camphors
(4) cinnamates,
(5) dibenzoylmethanes,
(6) p-aminobenzoates
(7) salicylates

These aromatic compounds absorb a particular region of the UVR spectrum that is typically employed in photochemical reactions like cis-trans or keto-enol photochemical isomerization or re-emitted at a less intense, longer wavelength (17). There are presently 23 organic sunscreen ingredients (including red petrolatum) available in the US for use in over-the-counter (OTC) sunscreen products (Table 1). Nine of these are typically used in sunscreen products, while the other two are either infrequently or never found in sunscreen products on the market today. Five of the nine sunscreens that are utilised make up the majority of sunscreens sold worldwide.Since no single organic sunscreen agent can offer a high UV protection factor when used at the levels currently permitted by the U.S. Food and Drug Administration (18), the organic sunscreens are virtually always combined (SPF). Additionally, combining organic sunscreens can enlarge their very narrow absorption spectrum. Depending on the intended product usage, such as recreational or daily photoprotection, and the required qualities, such as waterproof or sweat-proof, specific mixtures of organic sunscreens are widely utilised. Recently, the use of sunscreens that combine organic and inorganic ingredients has grown in popularity.

B. Organic (chemical absorbers) Organic UV filters that are excited to a higher energy state, like benzophenones, absorb UV rays. Typically, these are aromatic compounds joined together by a carbonyl group. Based on the range of protection, they are roughly divided into three categories: broad-spectrum sunscreens that cover the whole spectrum (290-400 nm), UVB (290-320 nm), and UVA (320-400 nm) (12). Particularly, several organic filters (such as PABA, PABA derivatives, and benzophenones) exhibit significant adverse effects, such as eczematous dermatitis, burning sensations, and an elevated risk of skin cancer(14,15).Inorganic sunscreens have been utilised in beach and daily use photoprotection goods more frequently during the past ten years. This has been influenced in part by concerns about the potential negative effects of organic sunscreens as well as their safety and effectiveness, particularly in blocking UVA. Unlike organic sunscreens, which may be changed by light energy, inorganic sunscreens are often thought of as innocuous pigments that cannot penetrate the skin. Titanium dioxide (Ti02) and zinc oxide are the two inorganic sunscreens that are most frequently used (ZnO). Although the appearance and attenuation spectra of these two metal oxides are very different (42), they do share several common characteristics that are briefly reviewed.In the form of odourless, white powders with a Gaussian or normal distribution of particle sizes, zinc oxide and titanium oxide are both present. The average particle size of the microfine powders used in sunscreen products is 0.20 pm (micron) or smaller, with a restricted and well-controlled dispersion. In contrast to the traditional pigment grades of these metal oxides that have been used for years in cosmetic products, it is significant to note that microfine powders do not contain smaller particles; instead, the lower end of the typical particle size distribution is enhanced through specialised manufacturing techniques. To put it another way, although microfine powders have always been present in ZnO or TiO, products, they were optically suppressed by the larger particles. Thus, microfine particles do not represent an entirely new particle size, just a refinement of the existing particle size distribution.Every particle has a size at which it scatters visible light the most (19). For usage as a white or coloured pigment, this size is appropriate. However, as the product is a sunscreen, any colour that a component gives it is unwanted. As a result, a metal oxide's average particle size is decreased below the ideal light scattering size, allowing visible light to pass through and making the oxide practically undetectable on the skin. This characteristic has been leveraged to produce the microfine metal oxide grades that are now frequently seen in sunscreen and everyday skin care products.In order to aid in dispersion, zinc oxide, also known as TiOz, is frequently coated with other substances including silicones, fatty acids, or oxides of aluminium, silicon, or zirconium. To lessen particle agglomeration, which enhances the distribution of particles when applied as a thin film on a surface, the paint industry created the coatings. The right coating increases the particle's compatibility with the dispersion medium, enhancing aesthetics and lowering processing costs in the process. Additionally, coating might lessen any possible metal oxide photoreactivity (20).

C. Natural / Systemic (chemical absorbers) Due to their long-term positive effects, particularly against free radical generated skin damages and UV-rays blocking, natural chemicals such as polyphenols (flavonoids, tannins), carotenoids, anthocyanidins, few vitamins, triglyceride oils, volatile oils from vegetables, fruits, medicinal plant parts (leaves, flowers, fruits, berries), algae, and lichens are more effective than synthetic chemicals (9). These sunscreens are absorbed by the body and build up on the skin, protecting against UV radiation. (16)

Aloe vera:

Fig 1. Alovera

Aloe vera gel is produced from the leaves of A. barbadensis and Aloe vera. Because of its hydrating and rejuvenating properties, aloe vera gel is frequently used in cosmetics and toiletries. It protects against UVA and UVB rays while preserving the skin's normal moisture balance. Aloe's bradykinase enzyme prevents sunburns and stimulates immune system response. The synthesis of fibroblasts and collagen is boosted, and the repair phase is sped up by acemannan, a D-isomer mucopolysaccharide. As a result of having spectrophotometric peaks at about 297 nm, aloe extracts and aloin from the plant can function as a sunscreen for both skin and hair [21,22,23].

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 [24].

Tomato:

Fig 2. Tomato

Lycopene is mostly found in tomato (Lycopersiconesculentum) fruit, which is also being researched for its antioxidant potential in the cosmetic and pharmaceutical industries. Lycopene, a powerful antioxidant and anti-carcinogenic carotenoid with great reducing activity, is abundant in tomatoes and has received extensive research. The pigment lycopene gives tomatoes their red colour. It is more than just a pigment; it is also a potent antioxidant that destroys free radicals, particularly those produced by oxygen and found in the lipid membrane and skin. Lycopene neutralises lipid radicals, lowers lipid peroxidation, and shields the skin from erythema brought on by UV rays. Lycopene may lessen the skin-damaging effects of UV light and increase protection against both the immediate (sunburn) and long-term (cancer) effects of sun exposure [25,26,27].

Pomegranate:

Fig 3. 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.Three commercial sunscreen products, Parasol1 (Crop Care, Australia), Surround1 (Ag Nova Tech, Australia), and Anti-stress-5001, were tested for effectiveness (EnviroShield Products Co., USA) Pomegranate fruit was planted in Condobolin, New South Wales, Australia, to reduce sunburn damage. According to the findings, sunscreen treatments had a significant impact on the category of fruits with severe sunburn damage ($p = 0.05$). When compared to control fruit (25.8%), fruit treated with Surround1 (14.7%) and Parasol1 (12.8%) had considerably fewer fruits with serious damage; the effect of the anti-stress 5501 (19%) was not significant [28,29].

Green Tea:

Fig 4. 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).In addition, it includes the alkaloids theophylline and obromine as well as caffeine, flavonoids, and phenolic acids. According to Wang et alstudies, .'s green tea given to SKH-1 hairless mice in drinking water had a dose-dependent prolongation in the interim of tumour development when they were subjected to a photo carcinogenesis protocol, providing the first evidence that green tea polyphenols might have a protective role in UV-induced skin cancer. Green tea has very little UVB or UVA absorption, is effective when administered systemically, and provides protection against at least some of the biological effects of ultraviolet radiation when treated right away [30,31,32].

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 cm2) before UVB (4 MED) exposure to human skin significantly blocked UVB-induced infiltration of leukocytes and reduced myeloperoxidase activity [33,34]

Cucumber :

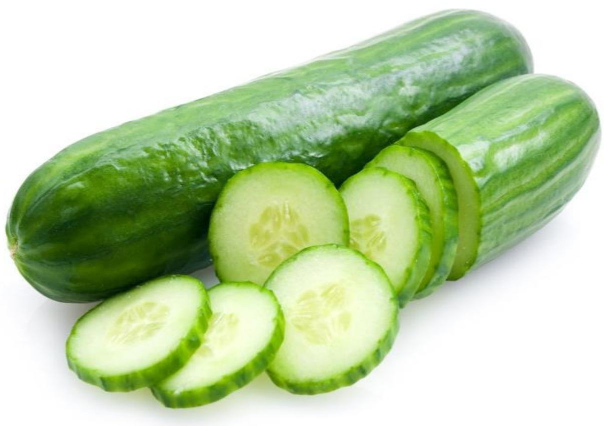

Fig 5. Cucumber

Extract from cucumbers (Cucumissativus) is both highly moisturising and slightly astringent. Additionally, it helps tighten skin and eliminate dead skin cells. Cucumbers are abundant in water, fibre, and healthy minerals. They also relieve skin irritations and reduce water retention. Caffeic acid and ascorbic acid, both of which are found in cucumber and which help to alleviate skin irritations, are also present. Cucumbers are beneficial for swollen eyes, burns, and dermatitis when administered topically because these two acid components minimise water retention.

The effectiveness of cucumber lotion sold as a natural sun protectant was examined by Hogade Maheshwar et al. By using two different dilutions (100 & 200 g/ml) of marketed cucumber product in ethanol, fresh cucumber extracts and marketed cucumber product were compared. All aliquots' absorbances were measured at various wavelengths between 250 and 350 nm, at intervals of 5 nm. According to the procedure described by Mansur et al, the invitro SPF values were calculated at wavelengths between 290 and 320 nm and favourable results were obtained [35,36].

Grapes:

Fig 6. 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 antiinflammatory and antiproliferative activity [35].

Indian Beech Tree:

Fig 7. Indian Beech Tree

Pongamiapinnata leaf extracts in several solvents (Aq, methanol, and acetone) were compared to the usual sunscreen medication, p-aminobenzoic acid, for their ability to block UV rays. Using a UV-visible spectrophotometer, the absorption spectra of several solvent extracts of this plant were measured. In the UVB zone, the aqueous and methanol extracts were shown to be quite effective, however in the UVA region, they were only moderately effective. It was discovered that acetone extract considerably absorbed only in the UVA region. This plant's leaf extracts exhibit good UVA absorption as well as overall UVB absorption. Consequently, P. Pinnata extract can be used to create sunscreen formulations that are quite efficient [36].

Almond:

Fig 8. Almond

Commercially, an almond is known as almonds. In particular, flavonoids and phenolic acids are abundant in seeds' polyphenolic components. This plant's skin extract was evaluated for its UVB protection ability. The effects of UVB radiation on the mice were examined for changes in lipid peroxidation and glutathione levels. Mice exposed to radiation showed decreased levels of lipid peroxidation and increased levels of glutathione after applying the cream topically for 2 hours prior to and after exposure. The findings demonstrated that cream formulations with topical application have strong anti-oxidant and anti-photo ageing characteristics [37,38].

African tuliptree:

Fig 9. African tulip tree

Along the margins of tropical African roadways, the African tulip tree (Spathodeacampanulata) is a decorative plant. The plant's stem bark has been said to have anti-hyperglycemic, anti-malarial, antioxidant, and wound-healing qualities in the past. The anti-solar activity of the Spathodeacampanulata flower's methanolic extract was examined by Patil VV et al. The extract had strong absorbance in the 200–240 nm region and high absorbance in the 240–325 nm range. At wavelengths between 310 and 340 nm, there was a moderate absorption. The outcome demonstrated the extract's UV protection capacity and demonstrated its capacity to absorb UV rays. In comparison to dangerous chemical sunscreens, this plant offers a superior and safer alternative[39].

Saffron:

Fig 10. 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 UVabsorbing agent [40].

Natural Sunscreen Oils:

Shea butter:

Fig 11. 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.

Jojoba Oil:

Fig 12. Jojoba

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

Carrot Seed Oil:

Fig 13. Carrot 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.

Soybean Oil:

Fig 14. Soyabean

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 [41].

Evening primrose oil:

Fig 15. Evening primrose

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[42].

Formulation of sunscreen cream:

Initial stock solution was prepared by taking 1% v/v of oil in ethanol and water solution (40:60). Then from this stock solution, 0.1% was prepared. Thereafter, absorbance values of each aliquot prepared were determined from 290 to

320 nm, at 5-nm intervals, taking 40% ethanol and 60% distilled water solution as blank, using Shimadzu UV-Visible spectrophotometer(7). Briefly, an oil phase containing lipophilic substances and an aqueous phase containing hydrophilic substances were separately heated in a water bath to 80°C.Anisotriazine was investigated at the concentrations of 4, 6 or 8% while titanium dioxide was investigated at the concentrations of 8 or 12%[50,51]

SPF:

SPF stands for Sun Protection Factor, and the number beside it indicates how well the sunscreen protects skin against sunburn. Under ideal conditions (like in a laboratory), a sunscreen with higher SPF protection and broad-spectrum coverage offers more protection against sunburn, UVA damage and DNA damage than comparable products with lower SPF values[52] .

Preparation of sunscreen sample for SPF measurements:

200 mg of each sample were weighed, transferred to a 100 mL volumetric flask, and vigorously vortexed after being diluted to volume with 50% hexane in ethanol. After that, it is filtered using filter paper, with the first 10 mL being discarded. With 50% hexane in ethanol, a 5.0 mL aliquot was transferred to a 50 mL volumetric flask and diluted to volume. The volume was then finished with 50% hexane in ethanol after a 5.0 mL aliquot was transferred to a 50 mL volumetric flask (15,18). Each diluted sample has a final concentration of 20 ppm in 50% hexane and ethanol[10].

Physical characterization of screen cream:

In people with photosensitizing disorders or other conditions that make them exceptionally vulnerable to UVA and visible light, physical sunscreens are crucial. Chemical sunscreens can selectively absorb UVB and/or UVA(20) and are more aesthetically pleasing. The creams' appearance and texture were visually assessed. A Brookfield DV-III Ultra rheometer equipped with an LV spindle Number 4 at 10 rpm was used to measure the creams' viscosity values at 25°C in triplicate. The operating programme for the Brookfield Rheocalc was used to manage the rheometer. A pH metre was used to measure the samples' pH levels at 25°C(16,21).

Sunscreen Regulations:

Sunscreens are evaluated generally one of following method and fulfillslabeling conditions as per countries guidelines

• **US-FDA method:**The critical wavelength approach is used by the FDA proposal to quantify in-vitro UV transmission through sunscreen film. The crucial wavelength for sunscreens giving only UVB protection would be less than 320 nm, while the critical wavelength for sunscreens providing both UVB and UVA protection would be between 320 and 400 nm. To be branded as providing "wide spectrum" UVA and UVB protection, sunscreen products must have a critical wavelength of at least 370nm (the mean value must be equal to or greater than 370nm). [43]

• UK method of boot star rating: The UK method, called as Boots star rating system, also measures the UV transmittance through a sunscreen film. The substrate for measurement is abraded PMMA plates. The ratio between the mean UVA and UVB absorbance measured before and after irradiation of the sunscreen products is calculated.[44]

• Australia: Australian standard (AS) method uses spectrophotometer for measurements of the solar radiation transmitted by a sunscreen product to yield a percentage of UVA radiation absorbed by the product. According to this test, a product is designated as a long wave protector only if it transmits less than 10% of the incoming UV radiation between 320 and 360 nm.the harmonisation of sunscreen product testing and labelling initiatives. Sunscreens of the liquid and emulsion variety are the focus of COLIPA guidelines. The evaluation of UV transmittance through a thin film (0.75 mg/cm2) of the sunscreen sample spread on a roughened substrate,**• European countries:**The cosmetics industry's COLIPA association voluntarily spearheads both before and after exposure to a controlled dose of UV radiation from a precisely specified UV source, should serve as the foundation for the test for UVA protection factors (UVAPF). With the PPD approach, it is possible to quantify UVAPF values in vitro, which has been found to have a good correlation with in vivo outcomes. [45]

• International Organization for Standardization (ISO): It is an independent, non-governmental international organization in Geneva with a membership of 162 national standards bodies.[46] Following are different methods of ISO for sunscreens:

• ISO 244:2012 specifies an “in-vitro” procedure to characterize the UVA protection of sunscreen products. Specifications are given to enable determination of the spectral absorbance characteristics of UVA protection in a reproducible manner. In order to determine relevant UVA protection parameters, the method has been created to provide a UV spectral absorbance curve from which a number of calculations and evaluations can be undertaken. This method relies on the use of in-vivo SPF results for scaling the UV absorbance curve.

• **ISO 24442:**2011 specifies an "in-vivo" method for assessment of the UVA protection factor (UVAPF) of topical sunscreen products. It is applicable to cosmetics, drugs and other products intended to be topically applied to human skin, including any component able to absorb, reflect or scatter UV rays. ISO 24442:2011 provides a basis for the evaluation of sunscreen products for the protection of human skin against UVA radiation from solar or other light sources.

• **ISO 24444:** 2010 specifies a method for the in-vivo determination of the sun protection factor (SPF) of sunscreen products. This International Standard is applicable to products that contain any component able to absorb, reflect or scatter ultraviolet (UV) rays and which are intended to be placed in contact with human skin. ISO 24444:2010 provides a basis for the evaluation of sunscreen products for the protection of human skin against "erythema" induced by solar ultraviolet rays. In below mentioned countries Sunscreens are evaluated generally by one of above methods and fulfillslabeling conditions as per countries guidelines.[47]

• **India:** Indian being Asian population comes under Type–IV skin pattern which burns minimally and tans easily. Freckles are rare but still use of sunscreen is necessary to avoid tan. Indian regulations date from the Indian Drug and Cosmetic Act (1940) as amended from time to time considers sunscreens as cosmetics. Bureau of Indian Standards (BIS), a participating member of the ISO, sets the relevant cosmetic product standards. Key points are stability data is (similar to Australia) must and there is no maximum SPF rating for sunscreens.

• **Japan:** Japan Cosmetic Industry Association (JCIA) provides self regulated standards. JCIA is a signatory to the COLIPA International SPF test method and JCIA has adopted ISO standards as they are published. For SPF, ISO 24444 is accepted. In Japan, for UVA, in-vivo testing is required and labelling is according to ratings of Protection Grade of UVA (PA) i.e PA +, PA++ and PA +++. Additionally, PA++++ was also added from 1st January 2013.

• **China:** Sunscreens are regulated under the Hygienic Standard for Cosmetics 2007. Currently sunscreens can only be labeled up to SPF 30+. The product must be labeled in Chinese language and have a Chinese name. Water resistance norms should be followed if lablled.

New developments:

Techniques for encasing chemical sunscreen components in innocuous tetraethoxysilane polymers are recent innovations. This microencapsulation promotes formulation flexibility, reduces allergic responses, and limits or inhibits systemic absorption of sunscreen. [48]

Another strategy is to combine the active components with hollow styrene/acrylate polymer beads. The beads increase the likelihood that the active substances will come into touch even though they do not absorb UV energy. In order to increase sunscreens' effectiveness across the entire UV spectrum, they work with both organic and inorganic sunscreens, allowing for a reduction in the amount of active sunscreen chemicals. [49]

II. 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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