**Patents on anti-aging and sunscreens**

Due to the widespread market value of the anti-aging and sunscreen products, constant developments are being made to come out with new formulations for the same. Many patents have been filed by researchers, a few of which have been compiled in this section.

Gershon et al.[77] formulated sunscreen preparation containing zinc oxide (ZnO) particles. The particle size of ZnO was tailored in such a way that they were within the maximum threshold of 80 nm and a minimum threshold of 30 nm. ZnO has the ability to absorb UV radiation and protect the skin from further damage. These particles were further coated with the optical coating material and suspended in a suitable media which was selected based on its refractive index. Two or more media were combined together to achieve the desired refractive index between 1 and 2. Integration of the multiple zinc oxide particles was performed by dispersing it in the first medium and applying the second medium on the top. The multiple manipulated zinc oxide particles were optically coated which contains silicon dioxide. Each of these optically coated multiple zinc oxide particles undergoes aggregation and forms one or more clusters of size greater than 200 nm. In these clusters, the multiple zinc oxide particles create optical separation. The aggregates comprise one or more binding agent with one or more nanospheres.

AleXiades-Armenakas[78] developed cosmetic preparation containing active ingredients to fight various signs of skin aging such as wrinkles, age spots, reduction in redness, acne, and rosacea. This single anti-aging skin care formulation contained 37 different microencapsulated ingredients which are protected from surrounding ingredients and also penetrates deeper strata of skin. The cream consisted of multiple ingredients along with a polymer base. The ingredients were selected based on their safety and efficacy, and belonged to the following categories, *viz*, DNA and cellular repair, anti-wrinkle, anti-redness and anti-pigmentation, antioxidant, anti UV damage, barrier repair, moisturizer, pro-collagen and an ingredient which prevents abnormal skin lesions. The ingredients having DNA repair and anti UV damage properties, procollagen were encapsulated in liposomes which contained soy lecithin to target epidermis. Cationic liposomes were chosen to ensure intercellular delivery of antioxidants including vitamin C and E. for deeper penetration into the dermis layer, the liposomes consisted of an edge activator, sodium deoxycholate which helps in barrier repair and acts as an emollient.

Armand[79] formulated an anti-aging cream containing equal mixture high molecular weight hyaluronic acid (HA) and low molecular weight hyaluronic acid oligosaccharides. Water-based hyaluronan was prepared to repair and prevent skin aging by preventing transepidermal water loss, damage to skin elastic fibers. This mixture of hyaluronan helps in the production of new collagen, skin keratinocytes, and extracellular matrix components. Low molecular weight hyaluronic acid oligosaccharides were prepared by hydrolyzing high molecular weight hyaluronic acid with testicular hyaluronidase, followed by its purification using ion-exchange resins. The obtained oligosaccharides were chemically deacetylated and mixed with an equal amount of high molecular weight hyaluronan in the final formulation. The penetrability of the formulation into the dermis was assessed using artificial skin and nude mice using isothiocyanatofluorescein coupled hyaluronan oligosaccharides.

Zahner[80] formulated a topical sunscreen lotion containing ingredients in its natural state. This natural sunscreen with an aqueous phase had the composition as follows: melanin, green tea extract with a polyphenol, mineral pigments of titanium dioxide or zinc oxide. This all natural sunscreen lotion was formulated with the active ingredients such that it would provide desired SPF, protection of cell from free radicals and level of water resistance. The green tea polyphenols possess synergistic photoprotective effects on skin when combined with

$TiO_2$and ZnO and are effective in reducing erythema. Melanin present in the formulation is a superior free radical trap, and it is also capable of regenerating the neutralized polyphenols of green tea. The mineral pigments, $TiO_2$ and ZnO, are said to be active UVA/UVB reflecting sunscreen ingredients which provide UVB protection of 75% for SPF 4, 88% for SPF 8 and 93% for SPF 15. These mineral sunscreens are left untreated such that this sunscreen composition remains in all natural state.

**Toxicity aspects**

There are certain ingredients in the sunscreen that might cause hormonal changes in the body. Oxybenzone is an organic filter which absorbs UV radiations especially UVB radiation, and it is systemically absorbed and excreted in urine and feces.[81] Oxybenzone is one such ingredient which affects the estrogenic levels in the body, and it has the highest rate of photoallergy among other UV filters.[45] However, it was speculated that this effect could only be seen in individuals who would use the product continuously for a longer period for about 35-277 years.[54] Nanoparticles can also cause local and systemic toxicity. Titanium dioxide and zinc oxide are reduced to nanosized particles so there is a great concern that these particles would penetrate the skin and produce UV induced free radicals.[81] Continuous use of the sunscreen will prevent the exposure of the skin to UVB radiations thus there would be insufficient vitamin D synthesis in our body. Thus the individuals might not acquire the normal vitamin D levels which are required by the body. The dietary supplement would help to maintain the normal vitamin D levels in our body.[45] Some chemical ingredients in sunscreen might cause edema, erythema, and irritation.[82] To increase the patient compliance, several sunscreens have preservatives, fragrances, and other excipients which might induce allergic reactions in sensitive individuals. Patients with photodermatitis are likely to develop photo contact dermatitis to sunscreen.[83] Sunscreens containing p-amino benzoic acid (PABA) help to protect from UVB rays and is said to be water resistant.[42] But in vitro studies have shown that PABA interacts with DNA followed by UV radiations and might cause photocarcinogenesis.[48] Hence a careful selection of sunscreen is vital to reap its benefits.

**Regulatory requirements/guidelines**

As per the US Food and Drug Administration (FDA) laws, cosmetics products do not require pre-market approval from FDA. Nevertheless, these products are regulated by certain laws put forth by FDA.[84] However, if these cosmetics contain any ingredients which may alter the body function, these are categorized as 'drug' as per Food, Drug and Cosmetic Act (FD&C). It is the responsibility of the company which manufactures these products to ensure the safety of such products.[85]

***Labeling information on sunscreen products***

Some of the points which have to be displayed on the sunscreen label along with its explanation have been detailed below:

- Broad spectrum: The label should specify if the sunscreen is a broad spectrum one. Sunscreens which are labeled as broad-spectrum protect our skin from both UVB and UVA rays. For a sunscreen to be broad spectrum it has to pass FDA broad spectrum test that measures the transmittance or absorbance of ultraviolet radiations across both UVA and UVB regions of the spectrum.[86]
- SPF: SPF is an important claim to be specified on the sunscreen products. SPF gives a measure of UVB rays involved in burning and not UVA rays involved in ageing.[21] An SPF of 15 is

expected to protect the skin from harmful UV rays for about 150 min[87]. The levels of protection from different SPF rates are: SPF15 provides 93% of protection from UVB rays, SPF30 provides 97% of protection from UVB rays, and SPF50 provides 98% of protection from UVB rays (Figure 2).[88,89]

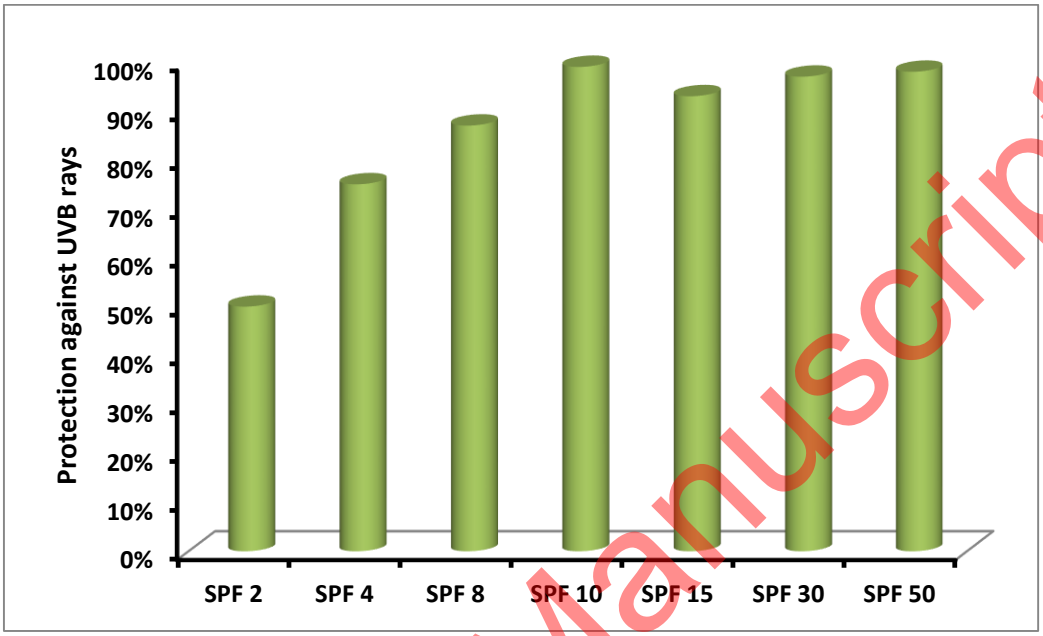


**Figure 2** Protection rate of sunscreens with sun protection factor (SPF) from ultraviolet B (UVB) rays

Thus we can conclude that SPF30 gives only 4% more protection and SPF50, about 5% more protection than SPF15.[88] So it is a misapprehension that higher SPF can give more protection than that with a lower one.[90]

- Water resistance: The sunscreen that claims to be water resistant should be reapplied for every 40 to 80 min which helps to provide protection while swimming and sweating.[91]
- Shelf life: According to FDA, the shelf life of the sunscreen should be at least three years. The sunscreen products which does not have an expiry date mentioned on it clearly indicates that the shelf life of the product is three years.[86] However, storage conditions can render the product unstable. Extreme temperatures also make the sunscreens less effective despite its expiration date.[51]

**Conclusion and future prospects**

Although the sun is beneficial and essential for life, exposing ourselves too much to sunlight might lead to detrimental health effects such as skin cancer. Studies and research have been conducted to introduce sunscreen in the form of pills for oral administration instead of reapplying the topical sunscreen repeatedly. Research and development are constantly underway to ensure that the sunscreen products are more effective and lessen the risk of adverse effects. Nanotechnology platforms have proved to be a major part of the cosmeceutical market owing to its better anti-aging and sunscreen potential which also renders a better skin deposition property and stability to the formulations. There has been ongoing research for the

use of photosynthetic microorganisms in sunscreens especially cyanobacteria which has great potential in protecting our skin from damaging UV radiation and intense sunlight. Such biological compounds have many potential advantages over current synthetically derived sunscreens. The synthetic compounds are being gradually replaced with natural compounds as the new source of protective agents owing to their better efficacy and safety.

**Conflict of Interest**

The authors confirm that this article content has no conflict of interest.

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