Sun Protective Agents (Sunscreens): Part 1

T. Bombeli, MD, BBA. Sunscreens were initially developed to protect against UVB radiation, as the available compounds were UVB absorbers. In the 1990s, compounds with UVA-absorbing ability became available. Sunscreens are very effective at preventing ery-thema, the endpoint used in sun protection factor (SPF) determinations. Sunscreens are formulated using a number of different active compounds to increase the spectrum of absorption. The active sunscreening agents are divided into 2 groups: organic and inorganic. The organic compounds protect the skin by absorbing UV radiation.

Organic (Chemical) Sunscreens

Organic or chemical sunscreens function in that the UV-radiation activates the electrons of the filter molecules from the passive in an short-time active condition. With returning into the stable condition, the energy is emitted as warmth or fluorescent irradiation while UV-radiation is “absorbed”. The absorption spectrum varies among the organic sunscreens: PABA esters, salicylates, and cinnamates absorb only UVB, whereas oxybenzone, octocrylene and Mexoryl XL are both UVA and UVB absorbers. Methyl anthranilate, Parsol 1789 and Mexoryl SX are only UVA absorbers.
Newly developed organic sunscreens include Tinosorb M (methylene bis-benzotriazolyl-tetramethylbutyl-phenol [MBBT]) and Tinosorb S (bisethylhexyloxyphenol methoxyphenyl [BEMT]). Tinosorb S is an enhancer agent able of increasing the effectiveness of avobenzone and octyl-methoxycinnamate.

Organic (Chemical) Sunscreens

PABA Esters
- Octyl dimethyl PABA (UVB)

Cinnamates
- Octyl-methoxycinnamate (UVB)
- Octocrylene(2-ethylhexyl-2-cyano-3,3-diphenylacrylate) (UVB/UVA)

Salicylates
- Octyl salicylate (UVB)

Anthranilates
- Methyl anthranilate (UVA)

Benzophenones
- Oxybenzone (UVB/UVA)

Dibenzoylmethanes
- Avobenzone (butyl methoxydibenzoyl-methane / Parsol 1789) (UVA)

Benzylidene Camphors
- Terephthalylidene dicamphor sulfonic acid / Mexoryl SX (UVA)
- Drometrizole trisiloxane/Mexoryl XL (UVA/UVB)

Inorganic (Physical) Sunscreens

The two inorganic or physical sunscreens, titanium dioxide and zinc oxide, are made from non-organic pigments which scatter UV radiation. In the micronized form (10-100nm) the particles can also absorb UV-radiation. A broad spectrum effect can be obtained by combining different particle sizes. Even the smallest particles do not penetrate into the skin, are chemically inert, unable to induce allergies, and work immediately after application. The negative aspects of physical filters are that they can whiten the skin. The micronized form is often preferred as they enhance the cosmetic acceptability.

Inorganic (Physical) Sunscreens

Zinc oxide (non-micronized or micronized)
Titanium dioxide (non-micronized or micronized)

Effects of UV Radiation and Sunscreens

UV-radiation, especially UVB (called **B**urning Ray), produces dilatation of the blood vessels in the skin and, after prolonged exposure, an inflammation (erythema). Depending on the UV dose the skin melanocytes begin to produce melanin, a protein responsible for pigmentation. UVA (called **A**ging Ray) produces less erythema and pigmentation than UVB but damages the skin by penetrating deeply into the dermis able of producing premature aging, wrinkles, and tumors. Several studies have shown that the regular use of sunscreens is associated with a decrease in actinic keratoses (aged skin) and a decrease in a special type of skin cancer (squamous cell carcinomas). Whether or not sunscreens can also reduce the occurrence of melanoma is still debated. Sunscreen use has also been shown to decrease the reactivation of herpes labialis (cold sore, fever blisters).

Sun Protection Factor (SPF)

The sun protection factor is a measure of the ability of a sunscreen to protect against erythema, which is thus primarily a measure of UVB protection. The SPF is a ratio of the dose of UV radiation required to produce a minimal erythema 24 hours after exposure in sunscreen-protected skin to the dose required to produce the same degree of erythema in unprotected skin. In other words: the SPF number defines how long you can stay in the sun before getting burnt. If it normally takes you 20 minutes in the sun before you get burned, an SPF 15 product will let you stay 15 times longer in the sun: 20 min x 15 (SPF) = 300 min (5 hours).

Vitamin D and Sunscreens

Vitamin D is synthesized in the skin following UVB exposure. Sunscreens are capable of decreasing vitamin D production in the skin and thus there has been a concern that sunscreen users will become vitamin D deficient. However, in a recent controlled study comparing sunscreen users to people using a placebo, none of the sunscreen users had abnormal vitamin D levels, even though they had been using sunscreen daily for 7 months.

Natural Sunscreens

There is increasing evidence that various natural compounds offer some UV protection. However, natural compounds do not scatter or absorb UV radiation but rather protect the skin cells from being damaged by UV radiation, mostly through antioxidant effects. Evidence of effective photoprotection has been accumulating with green and black tea. Oral tea, both green and black, has been shown to decrease the induction of skin tumors in hairless mice exposed to chronic UVB irradiation. In addition, vitamin C and E have both been found to have photoprotective and anticancer properties. The list below shows natural agents that have scientifically been shown to provide some photoprotective properties:

Biological Agents with Photoprotection

Green tea, black tea
Curcumin (Root of Curcuma longa)
Silymarin (Milk thistle)
Genistein (Soy, Ginkgo Biloba)
Garlic compounds
Resveratrol (Grapes, nuts, red wine)
Carotenoids (Carrots, tomatoes)
Vitamin C (many fruits)
Vitamin E (Plant oils)
Red clover extracts
Ferulic Acids (Olive oil, olives)

Side Effects

Allergic reactions to the active ingredients in sunscreens are fairly uncommon. In a study of 2715 patients who were evaluated by photopatch testing only 2.3% had positive photoallergic reactions, while benzophenone was the most common allergen.

Dosing of Sunscreens for Specific SPFs

For more information about selecting, combining and dosing sunscreens for specific SPFs, please refer to our website at www.makingcosmetics.com

Sources:
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Rosen C, et al. Dermatologic Therapy 2003;16:8