Sun protection products – appropriate use

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More and more day care creams are equipped with UV filters. While the production of sun filters skyrockets therewith, the endocrinal efficacy of some filters is being discussed by experts. Information on the state of the art and the most efficient way of protecting against sun radiation is compiled in the following.

A lot of people spend their working days indoors and thus cannot develop natural pigmentation. In other words, the enzyme tyrosinase that is responsible for the melanin formation remains inactive. Office workers also are identified by the fact that they quickly degrade the melanin gained during their vacation time.

Evidently, UV-B light (315-280 nm) does not arrive indoors; window glass only lets pass the residual UV-A light (380-315 nm; short-wave UV) above the wave length of 320 nm. Usually the angle of entry of sun radiation during summer into rooms is minimal so that the radiation has no chance unless a person sits right at the window or in the car. In winter, the angle of entry actually is wide enough however intensity and energy are minimal. Why do we then add UV filters to day creams? As a matter of fact there is no reason for standardly equipping day creams with UV filters. The worry that small amounts of radiation will trigger premature skin aging is clearly unfounded.

According to a study of the Federal Research Institute for Nutrition and Food (Bundesforschungsinstitut für Ernährung und Lebensmittel, Max-Rubner-Institiut) a major part of the population suffers from a significant deficiency of vitamin D. Vitamin D_3 (cholecalciferol) is a proven safety factor against various types of cancer including skin cancer and is formed above all under the influence of sunlight.

Similar to the preserving parabens and the diethyl phthalate contained in denatured alcohol, a number of UV filters are suspected to have endocrinal side effects or in other words they have hormonal effects. And to mention just a few of these substances with their INCI denominations: Ethylhexyl Methoxycinnamate, Butyl Methoxydibenzoylmethane, Octocrylene (2-ethylhexyl 2-cyano-3,3-diphenylacrylate), 4-Methylbenzylidene Camphor and several benzophenones. To what extent the suspicions actually are relevant still is controversially discussed among experts. So far the collected data is based on in-vitro-tests and animal studies which have their own specific conditions. It has been proven though that UV filters were responsible for isolated cases of photosensitization and allergenic and irritating effects. This results from the fact that their organic chemical structures contain extensive π-electron systems in the form of aromatic carbon and nitrogen compounds which are essential for the absorption of the high-energy radiation (photons) of the sun and their conversion into heat.

And yet, not all the filters show the same efficacy. With a higher time difference between radiation absorption and heat emission the probability also rises that reactive radicals are formed instead of heat. In this case we speak of a quantum efficiency which can be considerably lower in comparison to the natural melanin of the body (100%). Just to state an example: with a quantum efficiency of about 80%, about 20% of the photons are converted into radicals. Their lifecycle essentially depends on their environment (cream and skin components).

While inorganic titanium dioxide is able to generate free electrons under unfavourable conditions that in combination with water and oxygen further react into radicals, organic filters sometimes are chemically instable: in creams or in the case of exposure to light they are slowly degraded. In other words: Organic and inorganic UV filters will not provide an all-round carefree package.

Filters with low quantum efficiency often are combined with antioxidants (radical scavengers). It is recommended to refer to the INCI declaration in order to get detailed information. The inexpensive anti-oxidative butylated hydroxytoluene (BHT) for instance can trigger allergies in the case of a certain disposition.

Marginal conditions

Purposefully used, UV filters and sun protection products certainly are a blessing. Besides the UV-B protection they also have to guarantee UV-A protection up to at least one third of the declared UV-B sun protection factor. The

UV-A symbol (the letters "UVA" in a circle) then can be printed on the product label. Furthermore, the manufacturer has to warn consumers not to expose babies and small children to direct sunlight. A further indication is mandatory which describes the unavoidable infrared radiation (IR) combined with a recommendation of moderate exposure. It is the IR radiation that plays an important part in the premature skin aging process by affecting the collagen structures of the skin.

Appropriate exposure

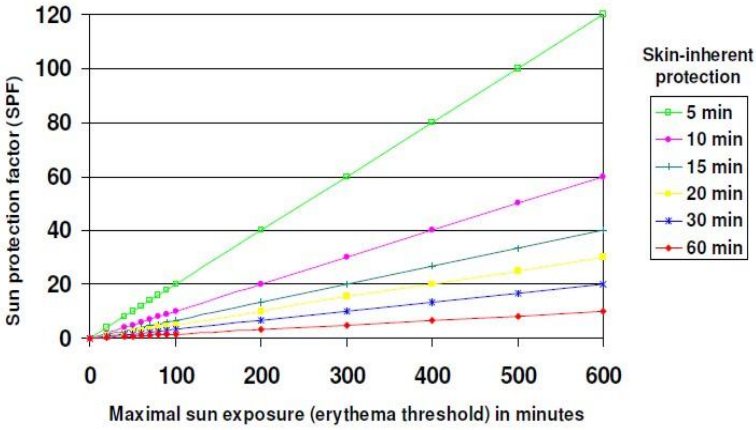
An appropriate exposure to sunlight implies that individual and environmental properties are observed. The natural self-protection time, or in other words, the maximal span of time a person can stay untanned in the sun without developing sun erythema, depends not only on the individual skin type but also on the following factors:

- **Daytime:** The position of the sun (angle of entry) naturally is at its highest at noon and hence the radiation is the most intense. Also the time difference due to daylight saving time in summer should be kept in mind.
- **Season:** During the central European winter (November – January) the natural self-protection time is extended enough even for very bright skin (Celtic skin type) so that the relevant values are not reached with sun exposure at sea level. Hence there is no need for sun protection.
- **Altitude:** The radiation intensity increases with the height above sea level and the natural self-protection time decreases. Hence alpine sports always require an adequate sun protection factor.
- **Reflecting environment:** Snow, bright sand and sparkling water surfaces reduce the natural self-protection time due to the reflected radiation.
- **Cloudage:** High and shady clouds reduce the sun radiation in so far that the natural self-protection time even in summer is appropriately extended - except for low latitudes. On the contrary, it is recommended to be cautious with light blankets of high fog and ground fog since the intense scattered radiation will soon lead to erythema in the case of sensitive skin.
- **Latitude:** In the tropics, the angle of entry of the sun amounts to 90 degrees at maximum. Hence the natural self-protection time quickly decreases along with the latitude. Even in the case of insensitive skin the natural self-protection lasts for a few minutes only.
- **UV-Index (UVI):** The Federal Office for Radiation Protection and also several other institutions inform on their websites on the UV index of various locations worldwide; considered are seasons, altitude and latitude. Depending on the skin type the recommended sun protection factor can be calculated by multiplying the UVI by 2 for dark skin and by multiplying by 4 for the fair skin type (and children). Between these skin types it is recommended to interpolate.

With the melanin content of the skin increasing in summer due to the sun radiation, also the natural self-protection time of the skin augments. This means that beginning with short exposures, the skin can be gradually accustomed to the sun radiation.
Caution is recommended for vacations by the sea side since most of the sun protection products consist of aqueous emulsions whose cream components are largely washed out in the (warm) water. Hence it is recommended to wear an overall bathing suit or alternatively light neoprene suit for extended snorkelling trips in the tropics.

Sun protection factor

The sun protection factor (SPF) indicated on sun protection preparations is multiplied by the self-protection time. The result then tells us the respective time that can be spent outdoors with the cream protection applied. With a natural self-protection time of 5 min in local environment and a product with SPF 15, the maximal sun exposure amounts to 5 x 15 = 75 minutes. The following chart in reverse allows calculat-



ing the sun protection factor based on the presumed maximum stay in the sun

In order to fully achieve the desired light protection, COLIPA recommends that the average adult should apply 2 mg/cm^2 of skin or in order words about 6 teaspoons (36 g) of sun cream for the entire body. The product should be well penetrated into the skin before sun exposure.

Preparations

Light protection products are offered as O/W or W/O emulsions in the form of creams or milks or as non-aqueous oils (liquid) or oleogels (semiliquid). The respective type of preparation rather is a question of individual preference. If the focus is on the water resistance of the product, W/O emulsions and non-aqueous preparations are the products of choice.
Since the Cosmetic Directive demands for a more complex risk assessment for non-biodegradable nanoparticles below 100 nm, many manufacturers decided to change to larger particles in the case of titanium dioxide. This may have sensorial consequences since, according to the Gauss distribution curve, the medium particle size has to be considerably larger than before in order to observe the threshold of 100 nm with the smaller particles.
Pigments of a make-up applied over the sun screen formulation generally add to the skin protection. Depending on the formulation, the factors may achieve 1 to 4. Iron pigments in the make-up or traces of iron in the environment (dust) may be disadvantageous since they will form radicals in combination with the UV light. That is why many sun protection products contain complexing agents such as EDTA (ethylenediamine tetraacetic acid). EDTA is known to be pretty persistent and also tends to form complexes with essential trace elements (as e.g. copper) in the skin. Unfortunately, sun preparations still contain ethoxilates and polyethylene glycols (PEG) as emulsifiers and consistency agents. They need to be stabilized with antioxidants and complexing agents since they otherwise form very aggressive ether peroxides which are suspected to trigger Majorca acne. Persons with very sensitive skin should avoid these formulations as well as products containing perfumes. The terpene structures of the perfumes form allergenic reaction products during sun exposure.
Unsaturated compounds which chemically are characterized by double bonds are another issue. They are not supposed to be components of sun protection preparations. This also applies for valuable essential fatty acids contained e.g. in vegetable oils. They are affected by UV-activated oxygen and form aggressive peroxides. It should however be mentioned that these problems can be avoided by applying omega-3 and omega-6 acid containing oils in the evening during summer months. Then they have strong anti-inflammatory effects, a fact that also is beneficial in the case of sun erythema.
Components such as amino acids and urea are excellent sun protection complements as they support the natural NMF and scavenge the unwanted radicals from the environment.

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