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Sun Protection and Sunscreen Labeling – An Update

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SUMMARY Sun exposure is today well recognized as having an adverse effect on human skin. Part of sun radiation, ultraviolet radiation A (UVA) and B (UVB), can modify skin structures and induce short-term skin changes (sunburn, tanning, hyperkeratinization, brown spots) and long-term skin damages (accelerated skin aging and skin cancers). Protection against both UVA and UVB is very important, therefore sun protection by clothes, avoiding sun exposure and correct use of sunscreens are important means to reduce short- and long-term solar radiation effects. The recommendation of appropriate sunscreen by doctors and cosmetic professionals (the function of skin type and sun radiation intensity) is today easier due to the recently implemented European uniform labeling system of sunscreens and detailed information for consumers.

KEY WORDS: sun protection factor, standardized "global" sun protection of a sunscreen, permanent pigmentation darkening and critical wavelength λc, UVA protection information, balanced UVA and UVB protection

Sun avoidance and clothing are important means of protection against the sun. Sunscreens have been a more controversial strategy for sun protection but recent prospective studies have shown that correct sunscreen use is important for the prevention of wrinkles and skin cancers (1-3). The choice of an appropriate sunscreen is made according to the information labeled on the sunscreen packs and tubes by the cosmetic industry. The main problem is that different labeling systems were used by different sunscreen manufacturers. This created real confusion among consumers. Recent European recommendations issued by the Comité de Liaison des Industries de la Parfumerie (COLIPA) (4) are now uniformly applied in Europe, making the choice for adapting sunscreens to each skin type or sun intensity easier.

The Sun Protection Factor (SPF) is an indicator of the ability of sunscreens to protect against sunburn (sun-induced erythema) (5-7). SPF is an international recommended method, by COLIPA in Europe, by the Food and Drug Administration (FDA) in the United States, and also accepted in other countries such as Japan, Australia, etc. This method is based on the assessment of the Minimal Erythema Dose (MED) determined in vivo (in healthy volunteers), using a lamp with Solar Simulated Radiation (SSR) (reproducing the solar radiation at 40° North latitude, in July, at 12 h) as the light-source. The method of calculation is the ratio between the protected MED and non-protected MED (Fig. 1). It is important to understand that SPF is a ratio indicating the property of a sunscreen to protect against sunburn (the higher the number, the higher the power to protect against sunburn). SPF number must not be understood as "n minutes longer in the sun" or "n times more powerful protector". SPF can also be determined in vitro (using an UV spectrophotometer) assessing the product's absorption range (Fig. 2). The

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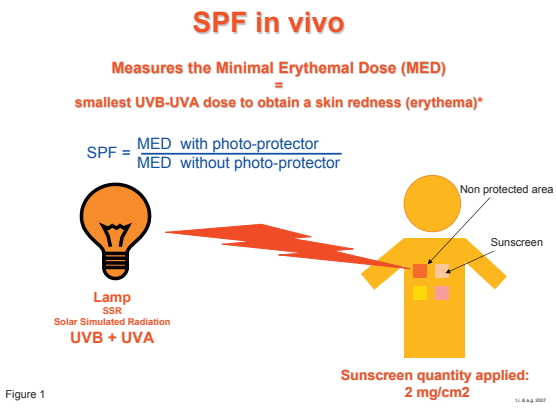


Figure 1

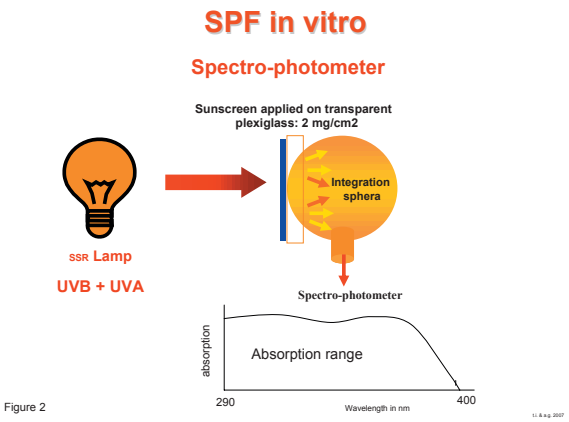


Figure 2

sunscreen is applied onto a perfectly transparent plastic screen. There is good correlation between the two methods (*in vivo* and *in vitro*).

For the SPF, COLIPA recommends categories of photoprotection, updated in 2007 (Table 1). All types of SPF tests use a standard quantity of sunscreen (applied on the volunteers' skin or on the plastic screen) of 2 mg/cm^2. This amount is imposed by SPF standard test requirements, while the actual sunscreen SPF is lower as people apply an amount of 0.5 to 1 mg/cm^2 on the skin (1,2). For this reason, high SPF sunscreens must be used for sun sensitive skins or light skins (SPF above 50). Different authors or laboratories propose practical examples of correct quantities of sunscreen that are closest to the correct amount (2 mg of sunscreen *per* cm^2 of skin) for better protection: for the face area we need "around 2 fingertips" of sunscreen, for the whole body we need a quantity of sunscreen in the "size of a golf-ball". The quantities can also be measured in "teaspoons" as shown in Table 2.

In the meantime, it is important to emphasize that high SPF sunscreens do not prolong intentional sunbathing and tanning.

Even though SPF is providing information on the attenuation of sunburn (meaning mainly good UVB protection), SPF gives no information on the sunscreen UVA attenuation. The Index of Protection (IP) is determined *in vivo* or *in vitro*, and concerns only one part of the UVs, UVB or UVA, the complete name labeled being IP UVB or IP UVA. The IP UVB *in vivo* or *in vitro* (usually labeled "IP") is based on the same testing methods as described above for SPF (assessing the same "sunburn" attenuation by a sunscreen), with a difference that the light source emits only UVB. For this reason, the results are different than those of SPF for the same sunscreen: IP is always equal or higher than SPF. IP is not recommended for sunscreen labeling anymore.

The IP UVA *in vivo* or *in vitro* testing methods are numerous (phototoxic method, immediate pigmentation darkening (IPD), permanent pigmenta-

Table I

Sunscreens labeling in 2007

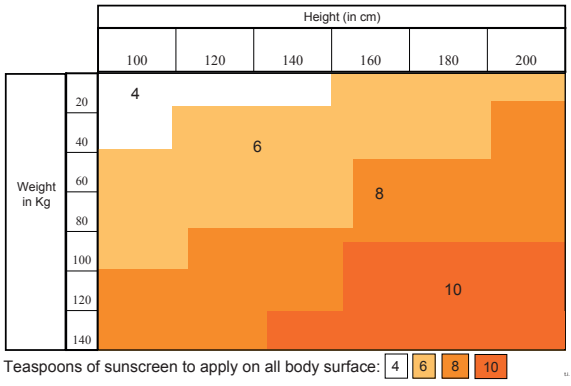
(according to COLIPA updated requirements)

Class of Protection	SPF labeled	SPF range
Low	6	6-9
	10	10-14
Medium	15	15-19
	20	20-24
	25	25-29
High	30	30-49
	50	50-59
Very high	50+	>60

Table II

Correct amount to apply: 2 mg of sunscreen per cm^2 of skin

Recommended number of teaspoons of sunscreen (1 teaspoon = 5g)
(proposed by Laboratoires Dermatologiques d'Uriage®)



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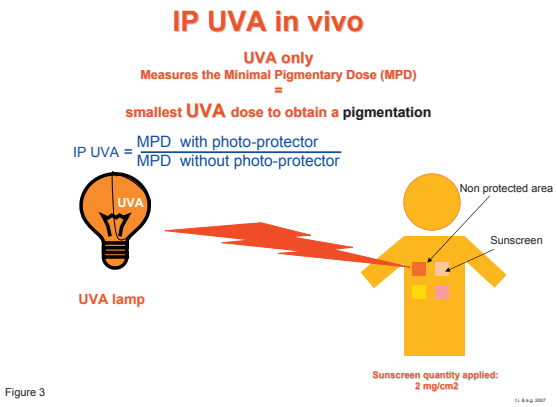

Figure 3

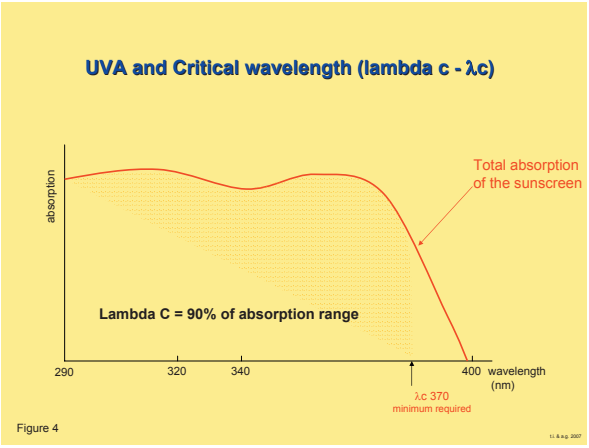

Figure 4

tion darkening (PPD), etc.). All these methods use UV lamps and assess the quality of a sunscreen to specifically attenuate UVA radiation (Fig. 3). Currently, PPD is the recommended UVA test.

PPD method is an *in vivo* test that assesses skin darkening induced by UVA lamp, measuring the lowest dose able to induce a grayish skin color at 2 h (Minimal Pigmentary Dose (MPD)). This phenomenon (8) is a transitory skin-darkening occurring immediately upon UVA exposure as a slight gray-brown skin color, fading progressively and stabilizing after 2 h. The mechanism of this process is poorly understood, being probably related to spatial rearrangement of melanosomes in keratinocytes and photo-oxidation of the pre-existing melanin. PPD is a stable and reproducible testing method assessing UVA attenuation of a sun protector.

SPF and PPD numbers are different for the same sunscreen, for example: a very high protection sunscreen can have an SPF 50 and a PPD of 25 (SPF measures attenuation of the sunburn and PPD attenuation of the skin darkening). Nevertheless, a good SPF to PPD balance must reflect perfect attenuation of both UVB and UVA. The European implemented SPF/PPP ratio is <3. This indicates good UVB-UVA protection and is labeled on the sunscreen tubes with a logo “UVA”.

SPF and PPD are not precise enough in providing information on the sunscreen quality to protect long-UVA radiation, which is the reason why critical wavelength is also part of the European Community recommended labeling items starting from 2007. Critical wavelength (λc) assesses sunscreen absorption of long-UVAs using the same method as described above for SPF *in vitro*: λc is the wavelength at which the product absorption reaches 90% of its total absorption surface (Fig. 4).

What indications provide SPF, PPD and critical wavelength? SPF and PPD indicate that the sunscreen is able to delay skin response after sun exposure (sunburn, transient pigmentation) compared to unprotected skin, while λc indicates protection against long-UVA radiation. None of these factors indicates directly the protection against UV-induced skin cancer or wrinkles.

In vivo long-term studies in humans concerning UV-induced carcinogenesis are ethically unacceptable, and the same holds for animal studies (the more so, results would be difficult to extrapolate to humans).

Several *in vitro* tests are used today as the comet test (cultured cells are UV-irradiated and compared to UV-protected cells, DNA of both cultured cells are examined under fluorescence microscope), oncoprotein p53 test (p53 is a human protein activated within cell nuclei upon UV-induced damage; the presence of p53 is a marker of nucleus UV-aggression). These tests (and other tests focused on immunosuppression induced by the sun) permit an approach to the protection against the photo-induced mechanisms of skin cancer. For the time being, there is no official international standard of these methods.

Prospective studies in sunscreen users have shown that external photoprotection is important in reducing the risk of skin cancers induced by solar radiation (1-4), and that “safe tanning” is a contradiction in terms (tanning being considered today as a marker of skin-aggression by the sun).

CONCLUSIONS

Medical recommendations and COLIPA requirement implemented in 2007 on sunscreen use are as follows:

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- Sunscreen protection as reflected by SPF should be the primary consideration for sunscreen "potency". Four classes of SPF simplify the message for users.

- SPF labeled number must be associated with labeled results of *in vivo* test of UVA-attenuation: PPD. A balanced UVB-UVA protection must be revealed by the SPF/PPD ratio of a minimum or equal to 3 (labeled with the logo "UVA").

- The *in vitro* critical wavelength (λc) method is a criterion for anti long-UVA protection and should be minimum or equal to 370 nm.

- Correct and complete information for sunscreen users must be included in the sunscreen leaflets/instructions for use or written on the packs.

- High SPF and PPD sunscreens must not prolong intentional sunbath.

- Apply an adequate amount of sunscreen (2 mg/cm^2) on the exposed skin areas prior to sun exposure; re-apply every 2 h and after each bath.

- Tanning is not good; seek shade.

Public education on sun avoidance, protective measures (wear UV-opaque hats, long-sleeve T-shirts and sunglasses) and topical application of sunscreens with a balanced anti-UVA-UVB protection should reduce the incidence of sun-induced skin cancer in the world.

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