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Importance of UVA Sun Protection: A Comparative Analysis of Different Quality Control Methods

■ Abstract

The globally accepted standard for the assessment of UV protection by a sunscreen formulation is the determination of its Sun(burn) Protection Factor (SPF). The SPF as a measure of UV-damage is emphasizing the impact of the shorter wavelength UVB radiation which with its higher energy is the main cause of sunburn and direct DNA damage. The effects caused by the longer wave UVA range are only minor with respect to sunburn yet major in relation to induction of pigmentation, to the formation of secondary radicals and thus also to DNA alteration as well as long-term effects on skin functions such as premature aging and malignity. Currently, the efficiency of UVA protection is assessed via the Persistent Pigment Darkening (PPD) method *in vivo* and by several *in vitro* methods, all based on the measurement of the UV transmission through a layer of sunscreen applied onto a UV transparent support. Contrary to the SPF method all these latter UVA methods are lacking a relevant biological endpoint. An alternative method that refers directly to a biological response mainly induced by UVA radiation is the Radical Skin Protection Factor (RSF) where UV-induced free radicals (Reactive Oxygen Species; ROS) are measured by Electron Spin Resonance (ESR), *ex vivo* in irradiated skin explants.

The aim of this study was to investigate whether the reduction of free radical generation is a measure for protection against UVA radiation. 16 commercial sunscreens in the SPF range of 15-60 and 6 daycare products of SPF 4-15 with vari-

able UVA protection were used to check this hypothesis. Besides the RSF value, the UVA-PF was determined *in vitro*, and SPF and UVA-PF were also assessed *in vivo* by the sunscreen simulator computer program. There is an average relation $UVA-PF = 0.33 \text{ SPF}$ over all samples confirming that half of them comply with the EC UVA recommendation. Among the half that complies the average relation $UVA-PF = 0.50 \text{ SPF}$ was found. The RSF is similarly correlated with the SPF; $RSF = 0.4 \text{ SPF}$ over all samples and $RSF = 0.55 \text{ SPF}$ for EC-UVA compliant half of the samples, but the variance is much higher leading to a correlation coefficient close to zero. The RSF was found to be related to the UVA-PF, $RSF = (1.0-1.3) UVA-PF$, depending on the SPF range of the samples. The deviation from the perfect correlation can be explained by the various influence factors on both methods. In conclusion, the RSF is able to provide the information on UVA protection which is required in addition to the SPF. On the other hand *in vitro* assessment of UVA protection can also serve as a valuable estimate of the RSF.

■ Introduction

UV radiation is the main culprit of several types of skin cancer and a key factor responsible for photoaging (1). Skin cancer and photoaging changes may result from ultraviolet (UV)-induced oxidative stress that induces a cascade of biochemical and biophysical reactions in the skin. Erythema is the most apparent result of the sunburn reaction, but the most serious results are photoaging and

photocarcinogenesis, largely mediated by reactive oxygen species (ROS). Mainly ultraviolet A (UVA) radiation (320-400nm) that penetrates into the deeper layers of the skin (epidermis and dermis) is responsible for the generation of free radicals (1, 2). The importance of adequate UVA protection has become apparent with improved understanding of the mechanism of UVA-induced damage to tissue. Thus, photoprotection, and mainly UVA protection, is crucial for preventing the undesired effects of sun exposure through sunbathing or in a daily skin care regiment. Photoprotection is mainly achieved by sun avoidance, clothing and the use of sunscreens containing organic and inorganic UV filters. According to several studies, it is possible to confirm that the regular use of sunscreens may reduce the harmful effect caused by long-term exposure to UVB and UVA radiation (1, 3). The urgent need to introduce UVA protection also in daily care products, especially for face day cream and hand cream, is a consequence of the understanding of the cumulative damage caused by UVA radiation to the skin.

The efficacy of photoprotection in cosmetic products depends on four key factors:

1. **Technology** to reduce the amount of broad spectral range of UV radiation that reaches the skin, possibly without changing the natural sun spectrum quality (spectral homeostasis). UV filters are the heart of this technology, but also the formulation of the sunscreen plays a crucial role. The best UV filter combination cannot perform, if

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the formulation is not right, i.e. spreads uniformly and sustainably over the skin.

2. **Assessment** of the performance of a sunscreen regarding SPF and UVA protection, i.e. the quantity (level) and the quality (breadth) of the protection. This paper is dealing with the assessment of UVA protection of sunscreens.
3. **Standards** for UV protection, e.g. the well established standards in Australia (4), United Kingdom (5) and Japan (6) and as recently released by the European Commission (7) and the US Food and Drug Administration (8) for SPF and UVA-Protection.
4. **Compliance** by the sunscreen user. The best sunscreen provides only insufficient protection if not applied uniformly, not in the right quantity or not at all.

Compliance is the most important key factor. The first three key factors all influence compliance. Technology affects the interaction of the components of the cosmetic products with the skin and thus the homogeneous distribution of the UV filters on the skin's surface and most importantly if the user likes the product. The topic of this paper is UVA assessment. The way UVA assessment is achieved and communicated can increase the credibility of a sunscreen, e.g. a relevant endpoint such as reduction of free radicals in the skin is desirable and may become as important a message as the »not-getting-sun-burned« message which is based on the endpoint of the well established SPF measurement.

Among the several methods (9, 10) to assess the efficacy of sunscreens, there are two main groups: *in vivo*-measurements that use biological endpoints such as erythema (SPF method) and pigmentation (permanent pigment darkening, PPD method), and *in vitro*-measurements that measure the transmission spectra of sunscreens applied to a carrier.

The *in vivo* measurements have two main draw-backs: firstly it is impossible to use the same biological endpoint for both UVA and UVB induced damages. Since

the SPF describes mainly UVB protection, especially as it is designed in the clinical laboratory testing, a separate assessment of the UVA protection is required. Persistent Pigment Darkening (PPD) is the commonly accepted *in vivo* method, although the PPD effect is not relevant in real life, unlike the erythema. The arbitrary classification in two ranges of UV irradiation does not reflect the biological effects and reality. Secondly, the use of test persons brings along problems of high variability of the results and ethical conflicts.

To overcome these problems related to *in vivo* measurements, the *in vitro* determination of the protective effect of sunscreens has been used for many years. All methods have in common the determination of the transmission of UV radiation that passes through the test formulation applied on a carrier (e.g. quartz or PMMA). Especially ratio methods such as UVA/UVB or UVAI/UV are very robust in predicting correctly the relative UV protection provided by a sunscreen (12).

Yet another method to assess sunscreen performance is the *in silico* calculation. Based on the absorption spectrum of each UV filter present in a sunscreen and the assumption of a film-model of the sunscreen distribution on the skin, bottom-up calculations can be carried out

(13, 14). The parameters in the sunscreen film model (e.g. step-film or another distribution) are adjusted by sunscreen reference samples of known (*in vivo*) SPF. Experience shows that such *in silico* calculations predict the SPF and the UVA indices of a sunscreen often more accurate than a transmission based *in vitro* measurement (15).

These methods allow obtaining reproducible measurements without interference of biological variability. However, exactly this absence of biological influence, i.e. the interaction of the applied sunscreen formulation with the skin, is the main deficiency of the *in vitro* measurements and *in silico* calculations.

There are two methods that try to overcome the defects of both *in vivo* and *in vitro* measurements by combining elements of both: one is the COLIPA UVA Guideline 2007 that determines the UVA-PF *in vitro* under consideration of the *in vivo* SPF (11), and the other the Radical Skin Protection Factor (RSF) using a completely different approach by measuring the UV-induced free radicals in skin, directly detected in skin biopsy samples. (16)

Fig. 1 shows the effectiveness-range of the SPF, UVA-PF and RSF method. The Erythema Effectiveness Spectrum calculated after the CIE action and sun spec-

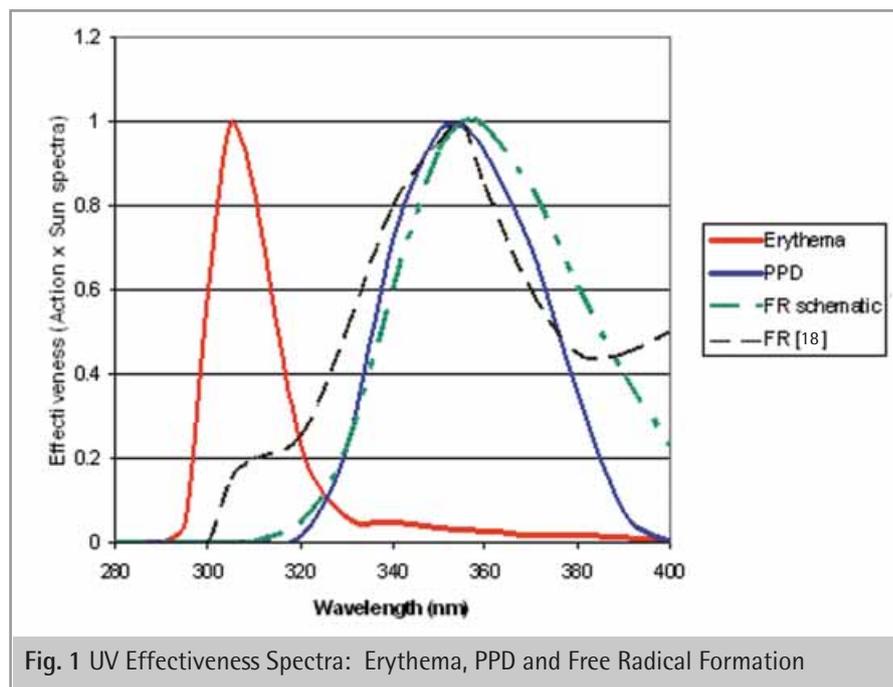


Fig. 1 UV Effectiveness Spectra: Erythema, PPD and Free Radical Formation

tra is located mainly in the UVB range (Effectiveness Spectrum = Action Spectrum x Sun Spectrum) (17). The effectiveness spectrum of the Free Radical Formation is depicted schematically by transformation of the erythema spectrum mainly into the UVA I range (340-400 nm). A recent publication of an effectiveness spectrum for free radical formation is added to the figure confirming this assumption (18). This figure shows that SPF and UVA-PF or RSF together should provide the information about protection in the full UVB/A range. Furthermore, we expect a good correlation between RSF and UVA-PF.

■ Materials and Methods

In the present work these two methods, UVA-PF *in vitro* and RSF, have been used to determine the sunscreen efficacy of 22 cosmetic market formulations. Their UV filter composition was determined by HPLC analysis (Table 1). All products contained organic and/or inorganic UV filters. The cosmetic products included oils, lotions, and sprays. The formulations were O/W or glycerin-based. Among these 22 products, 16 were declared as sunscreens and 6 were daily care products. From the UV filter concentrations, the SPF *in silico* was calculated (14) and compared to the labeled SPF. The UVA-PF was determined according to the COLIPA guideline 2007 (11). The RSF factor was determined as described by Herrling et al (16). In brief, the test products were applied on skin biopsy samples (pig skin, ear) at 2 mg/cm² labeled with a radical indicator, UV irradiated using a sun simulator and the amount of free radicals in the skin was directly determined by ESR spectroscopy.

■ Results and Discussion (Table 1)

UVA-PF determination (*in vitro*, COLIPA 2007)

The UVA-Protection Factor was determined according COLIPA 2007 guideline. Only half of the products fulfill the European Recommendation on UVA protection that requires the UVA-PF to be at least 1/3 of the labeled SPF (marked with »UVA-COLIPA-logo«, 8 out of 16 sun-

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Table 1 Studied sunscreens (1-16, yellow) and daily care products (17-22), green

N°	UV Filter UVB.....UVB/A.....UVA	Amount (%)	SPF		UVA-PF COLIPA	RSF
			Label	calc.		
01	OC	5,5	15	15,8	8,3	
	BMDBM	4,8				
	DTB	1,5				
02	OC	8,1	20	18,6	10,2	
	BMDBM	3,0				
03	TiO ₂	2,2	55	45,7	10,0	
	BMDBM	4,2				
	BEMT	4,6				
	PBSA	3,0				
	DTB	2,1				
	EHT	2,0				
04	EHT	1,6	20	6,3	2,4	
	TiO ₂	5,2				
05	TiO ₂	2,3	20	23,2	10,9	
	OC	9,1				
	BMDBM	2,5				
	DTS	1,5				
	TDSA	0,5				
	EHS	<0.1				
	BEMT	<0.1				
EHT	<0.1					
06	EHS	5,0	40	27,7	12,1	
	TiO ₂	2,8				
	BMDBM	2,5				
	OC	2,3				
	BEMT	2,0				
	EHT	1,0				
	DTS	0,5				
ZnO	0,1					
07	TiO ₂	6,3	25	20,3	7,8	
	BEMT	2,5				
08	EHMC	10,0	20	28,5	6,1	
	BEMT	2,0				
	MBBT	2,0				
	TiO ₂	0,1				
	ZnO	0,1				
09	EHMC	10,0	25	28,6	5,8	
	MBBT	4,0				
10	MBBT	7,4	55	63,1	28,2	
	EHMC	10,0				
	TiO ₂	5,9				
	DHHB	7,0				
	ZnO	0,7				
11	OC	10,0	30	30	16,4	
	BMDBM	5,2				
	TiO ₂	2,8				
12	BEMT	1,5	20	23,2	10,9	
	OC	9,1				
	BMDBM	5,2				
	MBBT	1,4				
	BEMT	0,5				

UVA SUN PROTECTION

N°	UV Filter UVB.....UVB/A.....UVA	Amount (%)	SPF		UVA-PF COLIPA	RSF
			Label	calc.		
13	OC	8,0	25	21,1	9,9	27,1
	BMDBM	2,0				
	TiO ₂	2,0				
	BEMT	1,0				
	EHT	0,3				
14	OC	9,1	20	23,8	11,2	18,2
	TiO ₂	2,9				
	BMDBM	2,5				
	DTS	0,5				
	TDSA	0,5				
15	PABA	5,5	20	8	1,1	2,1
16	OCR	10,0	20	23	3,9	4,1
	EHMC	7,8				
	DHHB	1,4				
17	EHMC	8,0	15	13	1,5	3,6
	PBSA	1,8				
	TiO ₂	0,8				
18	EHMC	7,2	15	17	3,6	5,1
	BMDBM	2,1				
	PBSA	1,5				
	TiO ₂	0,3				
19	OCR	1,6	4	3	2,1	3,9
	BMDBM	0,3				
20	OCR	5,0	15	15	12,3	11,8
	BMDBM	3,1				
	TDSA	2,1				
	DTS	1,5				
21	EHMC	5,0	8	8	2,5	7,5
	BMDBM	1,0				
22	OCR	4,1	15	18	5,0	8,0
	EHT	3,1				
	BMDBM	1,5				
	TiO ₂	0,3				
	MBBT	0,3				

Abbrev.	Use (x)	INCI	UV absorber	
			UVB	UVA
BEMT	7	Bis-Ethylhexyloxyphenol Methoxyphenyl Triazine	X	X
BMDBM	14	Butyl Methoxydibenzoylmethane		X
DBT	1	Diethylhexyl Butamido Triazone	X	
DHHB	2	Diethylamino Hydroxybenzoyl Hexyl Benzoate		X
DTS	4	Drometrizole Trisiloxane	X	X
EHMC	6	Ethylhexyl Methoxycinnamate	X	
EHS	2	Ethylhexyl Salicylate	X	
EHT	4	Ethylhexyl Triazone	X	
MBBT	5	Methylene Bis-Benzotriazolyl Tetramethylbutylphenol	X	X
OC	11	Octocrylene	X	
PABA	1	para-Aminobenzoic Acid	X	
PBSA	2	Phenyl Benzimidazole Sulfonic Acid	X	
TDSA	4	Terephthalylidene Dicapthor Sulfonic Acid		X
TiO ₂	13	Titanium Dioxide	X	(X)
ZnO	2	Zinc Oxide	X	X

screens and 3 out of 6 daycare products). In the column of the UV filters the absorption range of each UV filter is indicated, UVB, UVA or in between for broad-spectrum UV filters. There is only one sunscreen and one daily care product that contain neither a UVA nor a broad-spectrum UV filter (No's 15 and 17).

Recent surveys carried out in 2009 show that compliance of sunscreens increased whereas the majority of the daily products still provide inferior UVA protection. The reason for low UVA protection is only in 3 cases the lack of UVA or broad-spectrum UV filters (samples 4, 15 and 17). In 9 out of the 16 sunscreens and 5 out of the 6 daily products BMDDBM is found as UVA filter. Two of those latter cases are in combination with EHMC which makes the formulation unstable (daycream samples 18 and 21). All samples with SPF > 20 that fulfill the UVA-PF/SPF > 1/3 criterion (marked with UVA-logo) contain modern broad-spectrum or UVA filters (BEMT, DHHB, DTS, MBBT or TDSA).

SPF calculation (*in silico*)

It is possible to estimate the sunscreen performance based on its UV filter composition. The sunscreen simulator program (13, 14) is based on the spectra of the individual UV filters in diluted solution or dispersion. In addition an irregular sunscreen film assumed to simulate the real situation on the skin and to calculate the transmission. In 20 out of the 22 products (90%) investigated in this study the calculated SPF value is close to the labeled SPF, i.e. not further off than what we could expect as variation between *in vivo* SPF values tested by different testing laboratories. In two out of the 22 cases the calculation underestimates the SPF by far, i.e. #4 (SPF 20, calc. 6.3) and #15 (SPF 20, calc. 8). This may be explained by the special composition and formulation of the two products which apparently perform much better than expected. Sample # 4 is special because it contains only Titanium Dioxide as UV filter. It is also known from *in vitro* SPF measurements that the performance of inorganic UV filters TiO₂ and ZnO tends to be underestimated. Fur-

thermore there exist different grades of microfine TiO₂; not all of them are reflected in the sunscreen simulator. Sample # 15 only contains the organic UV filter PABA in an alcohol based formulation. This alcohol based formulation ap-

parently allows the spreading of the UV filter on the skin much more uniformly than in oil-in-water based emulsions which served as references to calibrate the model parameters of the sunscreen simulator program.

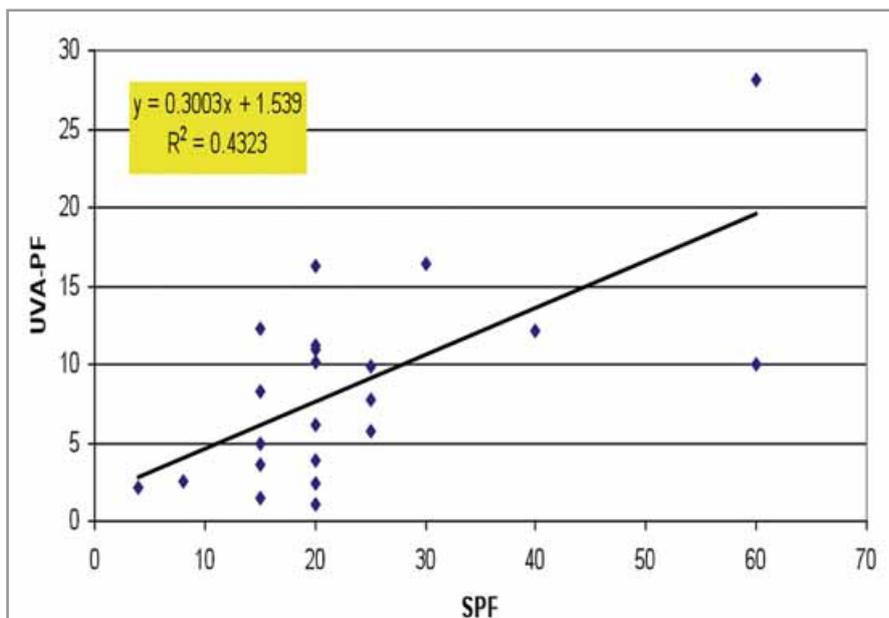


Fig. 2 Correlation between UVA-PF and labeled SPF (all samples, r= 0.67). The linear correlation line corresponds to the EC recommendation UVA-PF = 0.33 SPF. About half the samples of the study comply (above the line) and the other half does not (below the line)

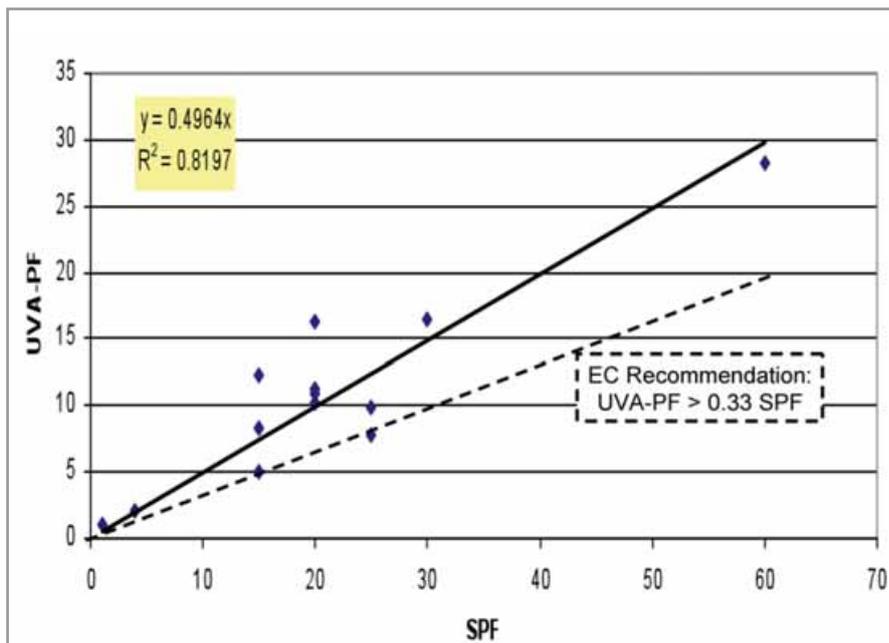


Fig. 3 UVA-PF = 0.5 SPF (r=0.91) for products compliant with EC-UVA recommendation

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- dl-alpha Tocopheryl Acetate
- Vitamin A Palmitate
- Niacinamide
- PBSA-Phenylbenzimidazole Sulfonic Acid
- OMCX-Octyl Methoxycinnamate
- BMDBM-Butyl Methoxydibenzoyl Methane
- Octocrylene
- Bisabolol
- Coenzyme Q10
- 1,3 Butylene Glycol
- Hyaluronic Acid
- L-Hydroxyproline
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The calculation program can also be used to determine the various UVA indices such as UVA-PF, UVA/UVB ratio, critical wavelength etc. The calculated UV transmission profile is shown for four selected samples in Fig. 6.

Correlation UVA-PF vs SPF

Although the SPF does not tell us about the UVA protection of a sunscreen, there is a correlation between UVA-PF and SPF in recent EU products according REC. Whereas it is possible to achieve SPF values below about 15 without UVA protection, this is not the case for higher SPFs since the UVA transmitted in the UVA range is also erythema-active (Fig. 1). In the study the correlation between UVA-PF and SPF is about $UVA-PF = 1/3 SPF$ with a correlation coefficient over all 22 samples of $r = 0.67$ (Fig. 2). This means that about half the samples comply with the 2006 EC-UVA recommendation (16). By introducing the UVA recommendation ($UVA-PF > 1/3 SPF$) the European Commission (EC) forced the UVA-PF to correlate better with the SPF. This can be seen by correlating only the upper half of the samples that all fulfill the EC recommendation. The average UVA protection expressed as the UVA-PF becomes half the SPF. i.e. $UVA-PF = 1/2 SPF$ with an even better correlation coefficient of 0.91 (Fig. 3).

The average RSF is similarly correlated with the SPF, i.e. $RSF = 0.4 SPF$ for all samples and $RSF = 0.55 SPF$ for all EC-UVA compliant samples, but with much higher scattering leading to a correlation coefficient close to zero. This higher scattering may have several reasons which are discussed below.

RSF determination and correlation

RSF vs UVA-PF

The RSF values are in most cases similar to the UVA-PF. There is a correlation $RSF = 1.1 UVA-PF$ over all samples, but not as good as expected; the correlation coefficient over all samples is only $r = 0.64$ (Fig. 4a). There seem to be a few outliers. A better correlation is achieved by eliminating the effect of the SPF level; only samples of SPF 20 were plotted in Fig. 4b. The UVA-PF range still varies from UVA-PF 1.1 to 16.3 in this series of 8 products with a strong correlation $RSF = 1.3 UVA-PF$

($r = 0.89$). The scattering that leads to a poorer correlation comes mainly from the samples with $SPF > 20$. Fig. 4c shows the expected correlation $RSF = 1.0 UVA-PF$, but with a very high variance ($r = 0.0$). Possible reasons for this high variance are discussed below.

Correlation N (Photons, skin exposure) vs N (Free Radicals, measured in skin) (Fig. 5)

There is an obvious correlation between the UVA-PF and the RSF. Whereas the

UVA-PF quantifies the number of photons penetrating the skin, the RSF determines the number of generated free radicals in the skin. Both quantities are in a direct correlation. The quantity of photons determines the number of generated primary free radicals in the skin such as super oxide anion ($O_2^{\cdot-}$) and hydroxyl radicals ($\cdot OH$). The number of daughter elements (secondary free radicals) like different forms of lipid radicals and others are influenced by the Antioxidative Potential (AOP) of the individual skin

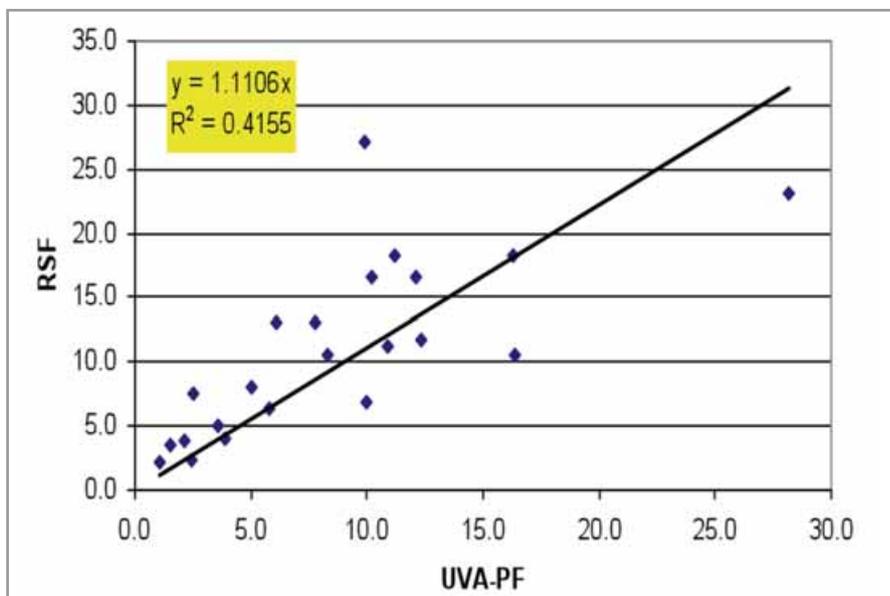


Fig. 4 a $RSF = 1.1 UVA-PF$ or all 22 samples ($r = 0.64$)

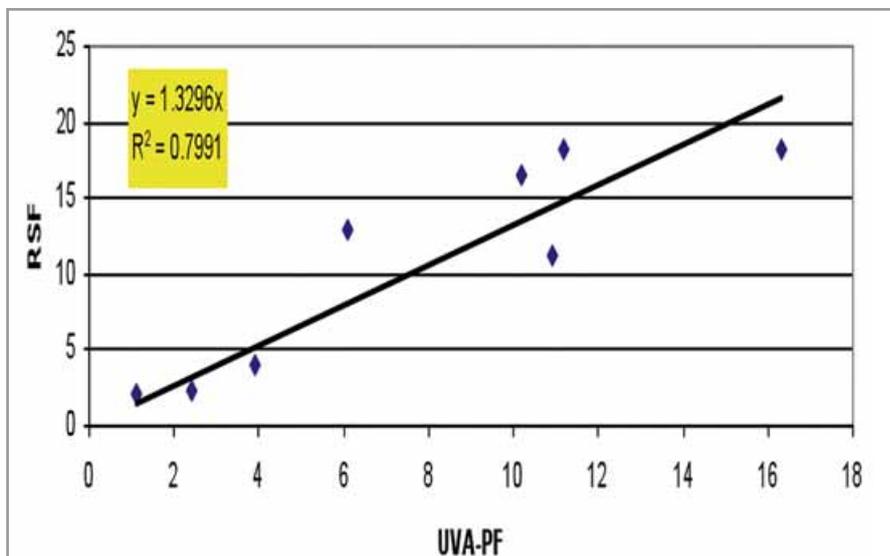


Fig. 4 b $RSF = 1.3 UVA-PF$ for 8 samples at SPF 20 ($r = 0.89$)

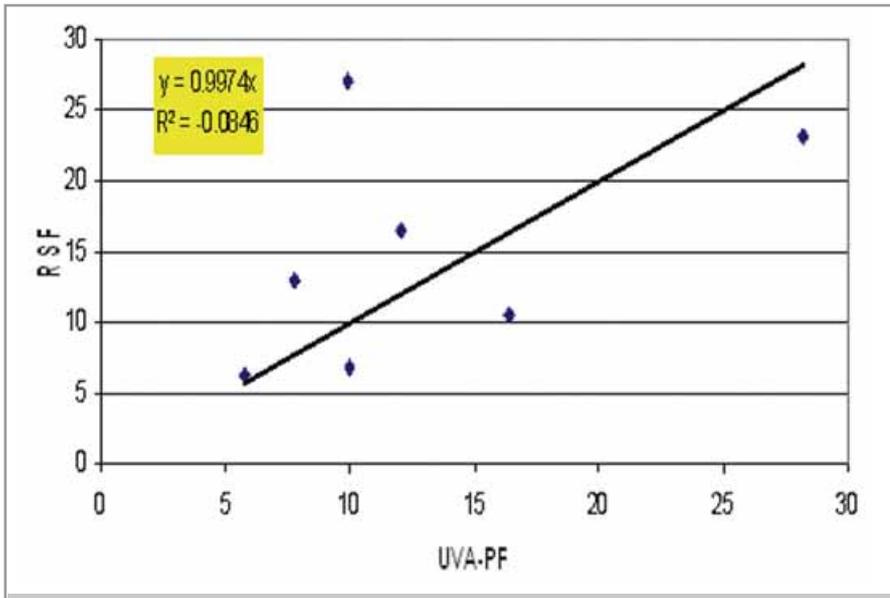


Fig. 4 c RSF = 1.0 UVA-PF, but high variance with 7 samples of SPF > 20 (r=0.0)

1. Allocability of the product on skin or plate
2. Penetration of the product into the test object (skin or plate)
3. Differences in reflection or absorption of the radiation from the product and the test object
4. Reactions between the product and the test object (skin or plate)
5. Humidity of skin or plate
6. Differences in photostability of the UV-filters (skin or plate).

In spite of all these numerous influences, an adequate correlation is seen between the two measured parameters UVA-PF and the RSF.

Since the RSF method is based on the detection of all UV-induced free radicals in skin (from oxygen free radicals up to lipid peroxides), it is the shortest connection between the cause (UV-radiation), the transmitter (free radicals), and the consequence (skin damage). Thus, the RSF is an ideal parameter for the characterization of the efficacy of cosmetics to protect skin against free radical injury.

(16). The AOP of the whole skin is determined by an intrinsic and extrinsic AOP. The extrinsic AOP can be influenced by the cosmetic product containing additionally antioxidants. The AOP of the skin influences finally the correlation between the UVA-PF and the RSF. This influence is expressed by the correlation factor (Cf):

$$N(\text{FR}\%) = C_f \cdot N(\text{Photon}\%) \text{ whereas}$$

$C_f > 1$ means free radical boosting
 $C_f < 1$ means free radical removing

This correlation between N(photon) and N(FR) after application of the different products is shown in Fig. 5. Differences between the UVA-PF and the RSF can be caused, for instance, by free radical boosters and free radical protectors (19). Other reasons for differences between the UVA-PF and the RSF are caused by the testing procedure itself which is caused by the generally known differences between *in vitro* and *ex vivo* measurements such as:

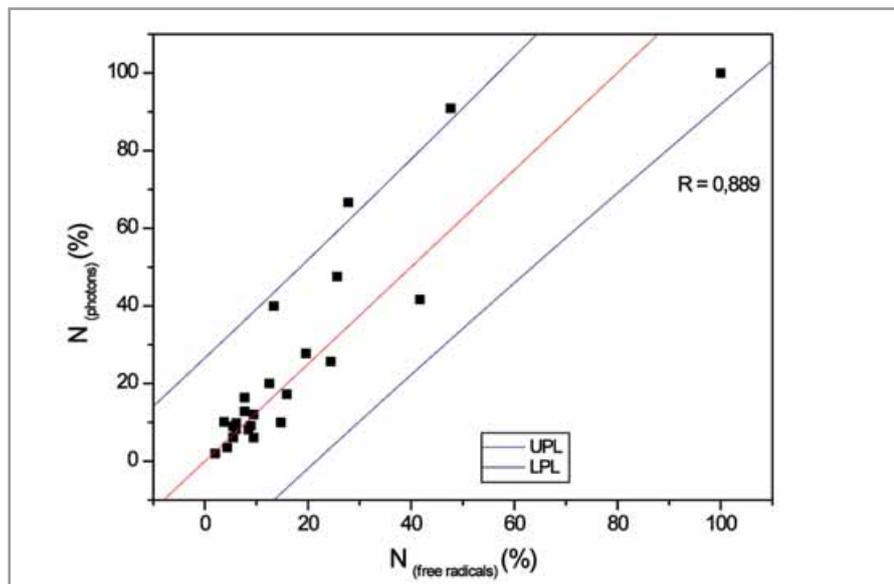
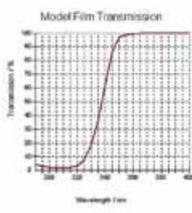
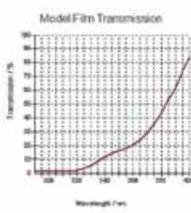
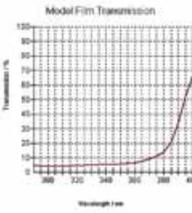
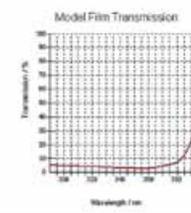


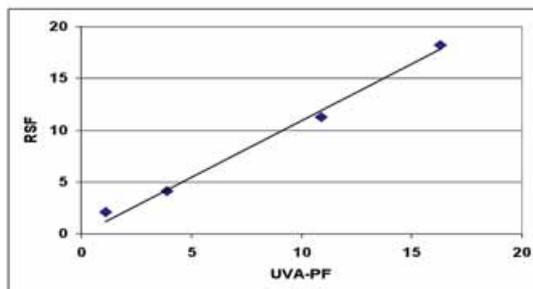
Fig. 5 Correlation between the Quantity of photons N(Photons) and the quantity of generated free radicals N(FR)

Evolution of UVA/Free Radical Protection (Fig. 6)

The four selected sunscreen samples in Fig. 6 (No's 15, 16, 05 and 12) demonstrate the evolution of UVA protection over the last decades. 10 to 20 years ago UVB-only sunscreens were very common (Sample No 15). With the higher SPFs this type of sunscreen disappeared. On the contrary day care products without photostable UVA protection or none at all are still common because no regulation is in place. The UVA protection in Europe is now also better than sample No 16 (Fig. 6). Still higher UVA Protection as demonstrated with sample No 12 is also common. There is a perfect correlation (R = 1.0) among the three samples showing the possible progress.

According to the US UVA-scale sample No 12 would fall into the »high« category (UVAI/UV = 0.93) just short of the

SPF 20 Sample	15	16	05	12
Transmission-Profile (Sunscren-Simulator)				
UVA-PF	1.1	3.9	10.9	16.3
RSF	2.1	4.1	11.3	18.2
European UVA-Rating	none	none	UVA	UVA
Proposed US UVA-Rating (UVA/UV)	No UVA Protection (0.05)	★★☆☆ Medium (0.64)	★★★☆☆ High (0.83)	★★★☆☆ High (0.92)



Correlation (r = 1.0):
RSF = 1.1 UVA-PF

Fig. 6 Evolution of UVA Protection in Sunscreens of SPF 20

»highest, 4 star rating« category. With the 4 star UVA category (UVA/UV > 0.95) the proposed US-FDA rule [8] sets the highest bar in the world regarding UVA protection. To reach this »highest« 4 star rating a practically uniform UV protection profile is required. This can only be achieved by a balanced combination of UVB, UVA and broad-spectrum UV filters. It is especially not possible with an excessive high UVB protection. Sunscreens or daily care products achieving the European UVA-recommendation will provide a good balance between UVA/ Free Radical Protection and SPF. Sunscreens or daily care products achieving a UVA/UVB ratio > 0.9 (5 BOOTS stars) or a UVA/UV ratio > 0.95 (4 FDA stars) will achieve practically uniform Sun Protection (e.g. No 12: SPF 20, UVAPF 16.3, RSF 18.2).

■ Conclusion

There is an urgent need to provide cosmetics with high UV protection over the whole UVA and UVB range. Assessment methods are a crucial element in providing good UV protection. Besides the conventional SPF (Sunburn Protection Factor) UVA protection is critical. This study shows that both the UVA-PF and the RSF provide equivalent results regarding its assessment. A similar assessment is possible with *in vitro* »UVA/UVB« ratio methods. The highest classifications in the UK (5 Boots stars) and the USA (proposed 4 UVA stars) indicate practically uniform »UVA-UVB« protection and thus achieve a similar protection factor against sunburn, UVA damage and Free Radical formation. Such a protection factor could be referred to as a truly *universal Skin Protection Factor* (uSPF).

Not only sunscreens but also daily care products should offer an adequate and modern concept of UV protection. Therefore it is crucial to apply the same assessment and categorization as it is now done for sunscreens.

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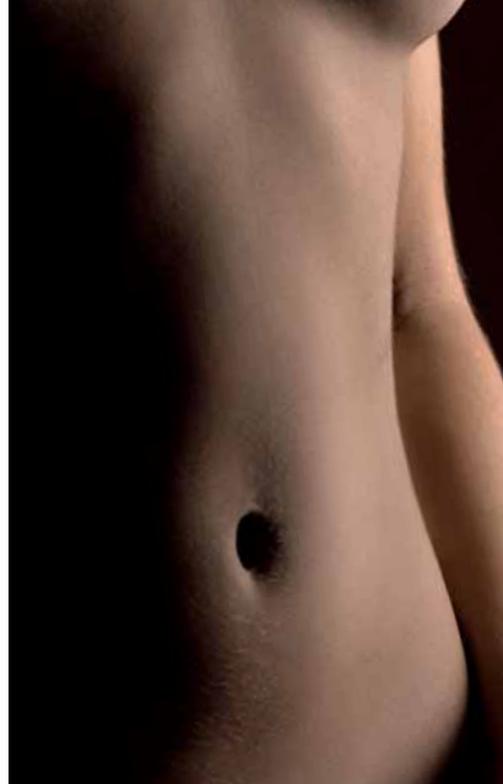
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