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SUN PROTECTION FACTOR DETERMINATION STUDIES OF SOME SUNSCREEN FORMULATIONS USED IN COSMETICS FOR THEIR SELECTION

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ABSTRACT

The study involves determination of sun protection factor (SPF) values of some sunscreen formulations for their use in cosmetics. The Sun Protection Factor (SPF) is a very popular instrument in the marketing of sunscreens. Sun protection factor is a laboratory measure of the effectiveness of sunscreen, the higher the SPF, the more protection a sunscreen offers against the ultraviolet radiations causing sunburn. It is often not understood how sunscreens work and where the limitations of the SPF are. A lot of aspects of the SPF are confusing, e.g. the race for higher and higher numbers, the effect on SPF when less sunscreen is applied and if sunscreen should be used at all because they may block the Vitamin D synthesis. The study explains how sunscreens work, how the SPF is determined and where the limitations of the current methods exist. The dynamic view of 'UV radiation applied' and the 'UV dose transmitted' through the sunscreen onto the skin as well as onto a substrate in vitro help in the understanding and are also promising approaches in the in vitro assessment. The study is helpful in selection of some sunscreens formulations used in cosmetics with better safety and high SPF values.

Keywords: Sun Protection Factor, SPF, Sunscreens

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INTRODUCTION

Sunscreens and sun blocks are chemicals that absorb or block UV rays and show a variety of immunosuppressive effects of sunlight. The use of skin care products specially sunscreens may be an effective approach for reducing UV-B-generated ROS-mediated photo-aging.[1-3] Solar ultra violet radiations (UVR) are divided into three categories: UV-C (200-280 nm), UV-B (280-320 nm) and UV-A (320-400 nm). UV-C is the most biologically damaging radiation, but it is filtered out by ozone layer. Currently UV-B radiation and to a lesser extent UV-A radiation are responsible for inducing skin cancer. [4-6]

SPF is determined by spectrophotometric method reported by Mansur *et al.* Hydro alcoholic dilutions of oils were prepared and *in vitro* photo protective activity was studied by UV spectrophotometer in the range of 290-320 nm. It was observed that the SPF values for cosmetic formulations were in between 13 and 16. Among the various sunscreen formulations SPF values were compared [7-8].

The efficacy of a sunscreen is usually expressed by the sun protection factor (SPF), which is defined as the UV energy required to produce a minimal erythemal dose (MED) in protected skin, divided by the UV energy required producing an MED in unprotected skin.

SPF = Minimal Erythema dose in sunscreen-protected skin/Minimal Erythema Dose in non sunscreen-protected skin)

The minimal erythemal dose (MED) is defined as the lowest time interval or dosage of UV light irradiation sufficient to produce a minimal, perceptible erythema on unprotected skin. The higher the SPF, the more effective is the product in preventing sunburn.

The *in vitro* screening methods are advantageous as they may represent a fast and reasonable tool reducing the number of *in vivo* experiments and risks related to UV exposure of human subjects. There are two *in vitro* methods (measurement of absorption or the transmission of UV radiation through sunscreen product films in quartz plates or biomembranes and the absorption characteristics of the sunscreen agents are determined based on spectrophotometric analysis of dilute solutions).

The *in vitro* SPFs were determined according to the method described. The observed absorbance values at 5 nm intervals (290-320 nm) were calculated by using the formula

$$SPF_{spectrophootmetric} = CF \times \sum_{290}^{320} EE_{(\lambda)} \times I \times Abs_{(\lambda)}$$

Here, CF = correction factor (10), EE (λ) = erythmogenic effect of radiation with wavelength λ, Abs (λ) = spectro photometric absorbance values at wavelength λ. The values of EE (λ) x I are constants. They were determined by Sayre *et al* and are given in Table 1.

Table 1: Values of EE (λ) x I at different wavelength

Wavelength	Value of EE x I
290	0.0150
295	0.0817
300	0.2874
305	0.3278
310	0.1864
315	0.0837
320	0.0180

However, there are many factors affecting the determination of SPF values, like the use of different solvents in which the sunscreens are dissolved; the combination and concentration of the sunscreens; the type of emulsion; the effects and interactions of vehicle components, the interaction of the vehicle with the skin; the addition of other active ingredients; the pH system and the emulsion rheological properties, which can increase or decrease UV absorption of each sunscreen. The effect that different solvents and emollients have upon the wavelength of maximum absorbance, alone or in combination, is reported in several studies [9-13]

Vehicles used for sunscreens formulations are hydro alcoholic lotions, water-in-oil or oil-in-water emulsions and oily lotions. The sunscreen preparation must spread on the skin, should remain in place as a continuous film, should closely adhere to the surface and should resist washing off by perspiration. Standard techniques for spectrophotometric evaluation of sunscreens preparations involve solution of a known weight of the screen or preparation in an ultraviolet transparent solvent. [14-15.]

MATERIALS AND METHODS

Sunscreen formulations of different manufacturers were procured and labeled (F_1, F_2, and F_3 & F_4) for studies. The maximum solubility was observed in 40% ethanol and 60% distilled water solution. Ethanol (Merck®) of analytical grade was used for preparation of stock and sample solutions.

Initial stock solution was prepared by taking 1% w/v of cream/lotion in ethanol and water solution (40:60). Then from this stock solution, 200□g/ml dilution was prepared. Thereafter, absorbance values of each formulation (F_1, F_2, F_3 &F_4) were determined from 290 to 320 nm, at 5-nm intervals, taking 40% ethanol and 60% distilled water solution as blank, using Shimadzu UV-Visible spectrophotometer (Shimadzu 1700, Japan).

Sun Protection Factor determination

The absorbance values of different formulations were taken between 290 and 320 nm, and the obtained absorbance values were multiplied with the respective EE (λ) values. Then, their summation was taken and multiplied with the correction factor.

RESULTS AND DISCUSSION

The effectiveness of a sunscreen formulation was illustrated in terms of SPF (sun protection factor). The SPF of different formulations (F_1, F_2, and F3 & F_4) was determined using UV spectrophotometer and is shown in table 2. The SPF values of different formulations ranged between, 9.39 to 16.72. The maximum SPF was observed in formulation F_2.

The study is helpful in selection of sunscreens formulations used in cosmetics with better safety and high SPF values.

The proposed methodology can also be used as a rapid quality-control method for the sunscreen formulations. Therefore the knowledge of SPF values will be a major tool in the selection of the various sunscreen formulations.

Table2: Absorbance of sunscreen formulations.

Wavelength (nm)	$EE_{(\lambda)}$ Employed	Formulation 1 (F_1)	Formulation 2 (F_2)	Formulation 2 (F_3)	Formulation 3 (F_4)
290	0.0150	0.061	0.016	0.061	0.080
295	0.0817	0.091	0.118	0.95	0.090
300	0.2874	0.118	0.301	0.120	0.160
305	0.3278	0.631	0.533	0.535	0.280
310	0.1864	0.864	1.646	0.624	0.395
315	0.0837	0.929	1.373	0.734	0.535
320	0.0180	0.694	1.147	0.896	0.743

Table 3: Sun protection factor values of different formulations

Name of formulation	SPF Values
F_1	11.71
F_2	16.72
F_3	10.04
F_4	9.39

CONCLUSION

The present study examines the SPF (sun protection factor) values of different formulations using UV spectrophotometer which is simple, rapid, and economic. The SPF values of different formulations were found in proximity with the reported values. Thus the studies help in the selection of some sunscreen formulations which is more effective in preventing the sunburns. The method can also be used further in the determination of SPF values of other cosmetic formulations successfully.

REFERENCES

1. Kaur CD, Saraf S, *Invitro* sun protection factor determination of herbal oils used in cosmetics, Pharmacognosy Research, 2010; 2 (1): 22-25.
2. Khan M.A, Engla G., Comparative studies on sun protection factor of some sunscreen formulations used in cosmetics, Research J. Topical and Cosmetic Sci. 2012; 3(2).
3. Khan, M.A., Studies on determination of sun protection factor of some sunscreen formulations used in cosmetics, World Journal of Pharmaceutical Research, 2013; 2(6):2437-2442
4. Ferrero L, Pissavini S, Marguerite, Zastrow L. Sunscreen *in vitro* spectroscopy: Application to UV A protection assessment and correlation with invivo persistent pigment darkening. Int J Cos Sci 2002; 24:63-70.
5. Bendove H, Akrman J, Krejci A, Kubec L, Jirove D, Kejlove K, *et al. in vitro* approaches to evaluation of Sun Protection Factor. Toxicol *in vitro* 2007; 21:1268-75.
6. Wood C, Murphy E. Sunscreens Efficacy. Glob Cosmet Ind Duluth 2000; 167:38-44.
7. Osterwalder U, Herzog B, Br. J. Dermatol, Sun protection factors: worldwide confusion, 2009; 161(Suppl 3):13-24.
8. Mansur JS, Breder MNR, Mansur MCA,Azulay RD. Determinagao Do Fator De Protegâo Solar Por Espectrofotometria. An Bras Dermatol Rio De Janeiro 1986; 61:121-4.
9. Pissavini M, Ferrero L, Alaro V, Heinrich U, Tronnier H, Kockott D, *et al*. Determination of the *in vitro* SPF. Cosmet Toiletries Oak Park 2003; 118:63-72.
10. Walters C, Keeney A, Wigal CT, Johnstom CR, Cornelius RD. The spectrophotometric analysis and modeling of sunscreens. J Chem Educ 1997; 74:99-102.
11. Ashawat MS, Saraf S, Saraf S. Photo protective properties of Boerhavia diffuse, Biosciences. Biotech Res 2006; 3:257-60.
12. Sayre RM, Agin PP, LeVee GJ, Marlowe E. Comparison of *in vivo* and *in vitro* testing of sunscreening formulas. Photochem Photobiol 1979; 29:559-66.
13. Riegelman S, Penna RP. Effect of vehicle components on the absorption characteristics of sunscreens compounds. J Soc Cosmet Chem 1960; 11:280-91.
14. Agrapidis-Paloympis LE, Nash RB, Shaath NA. The effect of solvents on the ultraviolet absorbance of sunscreens. J Soc Cosmet Chem 1987; 38:209-21.
15. Dutra EA, Oliveira DA, Kedor-Hackmann ER, Santoro MI. Determination of sun protection factor (SPF) of sunscreens by ultraviolet spectrophotometry. Braz J Pharma Sci 2004; 40:381-5.