In-Vitro evaluation of cutaneous penetration of sprayable sunscreen emulsions with high concentration of UV-filters

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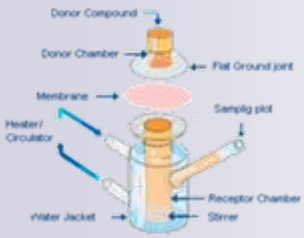
INTRODUCTION

The interest in sunscreen products is growing because the incidence of skin cancer has surged over recent years mostly because of the increased exposure to the sun. So it is important to develop sunscreen products with high concentrations of organic and inorganic filters. These high concentrations of UV-filters can be a problem in terms of accumulation in the skin, or in term of skin penetration. Moreover, it seems to be evident that sunscreen products have to stay on the epidermis surface to keep their UV-protecting effect. So it is important to evaluate and to control the possible cutaneous penetration in order to guarantee the efficacy and the safety of sunscreens products. The aim of this study was to evaluate the possible penetration through human skin of organic and inorganic filters contained in sunscreen emulsions conditioned in aerosol cans using an *in vitro* method. These experiments were investigated on two different types of emulsion: Water in Silicone (W/Si) and Water in oil (W/O).

MATERIAL AND METHOD

In-Vitro Study Conditions

Franz Cell diffusion



Receptor chamber: solution of 4% bovine serum albumin (BSA) in phosphate buffered saline (PBS).
*Volume:*13.5 mL stirred at 500 rpm
Temperature: 37 °C (skin temperature:32 °C).
Diffusion area: 5.31 cm^2.
Membrane: excised human skin.
Operating mode: Application of 2 mg/cm^2 of the sunscreen products.
The sampling times were 1h, 2h, 4h, 6h, 8h, 12h, 24h. At the end of the experiment, emulsions were removed from the epidermis and the rest of skin was treated in the aim to extract UV-filters left.

Analytic methods

Organic UV-filters

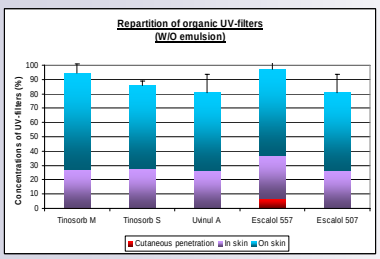
Organic filters: Escalol® *557*, Escalol® 507, Tinosorb® M, Tinosorb® S and Uvinul® A.
HPLC conditions: The flow rate of the mobile phase was 1.5 ml/mn. Injection volume was 50µl. Experiments were performed at 30°C. Absorption was measured at 310 nm and 360 nm for UVB and UVA filters, respectively. The mobile phase was a gradient of solvent: from MeOH:THF:ACN:H_2O with 0.5% of acetic acid (35:10:15:40) to MeOH:THF:ACN:H_2O with 0.5% of acetic acid (70:10:15:5) in 15 min.

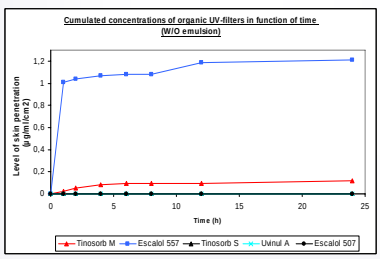
Inorganic UV-filters

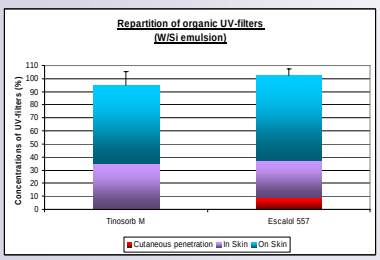
Inorganic filters: TiO_2 and ZnO.
Method of quantification: ICP-OES (Inductive Coupled Plasma-Optical Emission Spectrometer).
ICP-OES conditions: The ICP was operated at 1.20 kW, with a plasma flow rate of 15 L/min, an auxiliary argon flow rate of 0.5 L/min and a nebulizing pressure of 200 kPa. Sample signals were monitored 15 mm above the load coil. Ti and Zn were measured at 334.94 nm and 213.85 nm, respectively. Before analysing, samples were digested (furnace at 500°C during 10-12h) and mineralized (fusion with K_2SO_4 and dissolution in hot concentrated solution of H_2SO_4).

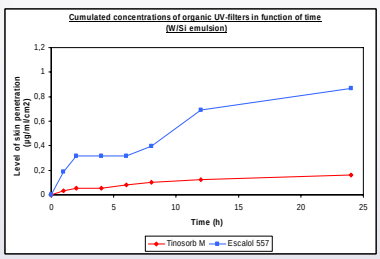
RESULTS AND DISCUSSION

Organic UV-filters

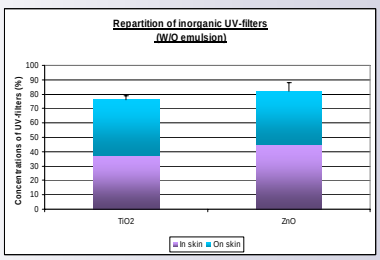


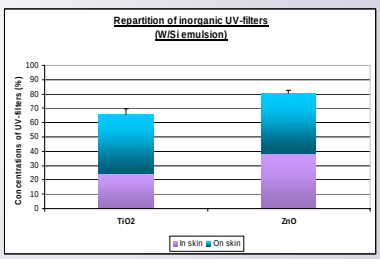






Inorganic UV-filters





Organic UV-filters: As we could see, only Tinosorb M and Escalol *557* showed a potential of skin penetration. Escalol *557* showed a maximum skin penetration of 1.21 µg/mL/cm^2 for W/O emulsion and 0.87 µg/mL/cm^2 for W/Si emulsion. The maximum cutaneous penetration for Tinosorb M were 0.12 µg/mL/cm^2 for W/O emulsion and 0.16 µg/mL/cm^2 for W/Si emulsion. Skin absorption is a passive phenomenon and molecules have to pass through different layers before reaching receptor solution. Diffusion depends on concentration of molecules. The higher is the sunscreen concentration in the preparation, the more important is the diffusion. The differences between each UV-filter could be explained by their different concentrations. Indeed, Escalol 507, Uvinul A and Tinosorb S were used at lower concentrations than Tinosorb M and Escalol *557*. The difference between Tinosorb M and Escalol *557* could be due to their molecular weight and to their configuration: Tinosorb M is bigger than Escalol *557*, so its capacity of skin penetration is less important than Escalol *557*. A difference between both types of emulsion was observed too. In fact, W/Si emulsion is less occlusive than W/O emulsion because lots of volatile silicones were used and its viscosity is lower in comparison to W/O emulsion. So the skin hydration was enhanced and it permitted a higher penetration (especially for Escalol *557*).

Inorganic UV-filters: No skin penetration was observed for TiO_2 and ZnO. However, we could observe an important capacity of accumulation in he skin: close to 50% for all experiments. This could be explained by the very small size of particles of both oxides, which are nano-sized particles.

CONCLUSION

A HPLC method for the determination of five common organic sunscreens was developed, in parallel with an ICP-OES method for inorganic sunscreen agents. Sprayable sunscreen products with high concentration of UV-filter, with a low rate of cutaneous penetration were developed. The use of validated analytical methods is necessary to evaluate the safety and efficacy of all new sunscreen products.

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