28-th EADV Congress, 09-13 October 2019, Madrid

In vitro study of medical device emulsion SPF 100 – skin protection for patients with high risk of sun damage

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Introduction

Sunlight induces numerous skin diseases, e. g. primary and secondary photodermatoses as well as actinic keratosis. It can also increase the risk of melanoma and non-melanoma skin cancer in humans. According to the current state of knowledge, a proper usage of sunscreens prevents photodermatoses, actinic keratosis and squamous cell carcinoma (SCC), but not basal cell carcinoma (BCC). Most of common sunscreens are formulated to protect against UV radiation (especially UVB to reduce the risk of sunburn), however they may not give a significant protection in the visible region.

The aim of our study was to develop a medical device emulsion with high SPF value, which can also protect skin cells against HEV (including blue light) and IR radiation, as well as show anti free radical and anti-inflammatory activity.

Methods

In order to evaluate safety and efficacy of medical device (Medical Device emulsion no. 16007) we performed in vitro tests: cytotoxicity on L929 cells according to ISO 10993-5:2009, 10993-12:2012 and skin irritation on EpiDerm skin model according to OECD test guideline 439 and ISO 10993-10:2013. Skin penetration of sunscreens from MD emulsion was measured *ex vivo* using Raman spectroscopy method (*Biomacromolecules, 2015, 16(11): 3603-3612*). SPF value was measured based on ISO 24443:2011 methods (using Labsphere UV Transmittance Analyzer) and the quantity of sunscreens during the storage time was evaluated by HPLC. Emulsion efficacy against visible and infrared light was measured by spectrophotometric method (Lambda 950) in short cut cuvette (*SOWF Journal, 2017, 143 (9): 20-24*). Level of protection was determined by the transmission rate of HEV and IR radiation. The antioxidant activity of the tested emulsion was determined using the 2,2-diphenyl-1- picrylhydrazyl (DPPH) radical scavenging method (*SOWF Journal, 1998, 124 (5): 282-284*).

Conclusion

Photoprotection, including daily application of broad spectrum sunscreens, combined with anti-inflammatory and anti-ROS activity compounds, can inhibit many adverse effects of sun radiation exposure and prevent actinic keratosis as well as reduce the risk of skin cancer.

In vitro experiments confirmed that the tested medical device emulsion has high photoprotective properties - it absorbs UVA, UVB, HEV and IR radiation and contains anti-inflammatory and anti-ROS activity compounds. Thus it can be recommended to help inhibit many of the acute and chronic effects of sunlight exposure.

Results

Medical Device emulsion SPF 100+ contained mineral and organic filters as well as *Laminaria ochroleuca* extract, with high amount of lipoic acid and strong anti-inflammatory activity via reduction of IL-1, Il-6, IL-10, PEG2, TNF-α, LTB4, COX2 after UVB radiation (*Mekideche N., Personal Care, 2002: 63-73*). Additionally, Canola oil obtained from the seeds of four species of rape plants, *Brassica napus, Brassica juncea, Brassica rapa and B. campestris* of the family *Cruciferae* (mustard family), due to the high content of natural sterols and vitamin E has been reported to show soothing and anti-inflammatory properties comparable to those of steroids (1% of hydrocortisone), *Loden M., Andersson A.C. BJD 1996: 134: 215-220.*

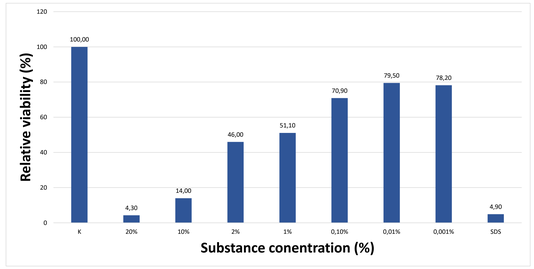


Figure 1. Cytotoxicity of MD 16007 on L929 cells. Viability <70% of the control - cytotoxic potential. Ref – 5% SDS. **The tested MD emulsion was non-cytotoxic at the concentration less than or equal to 0,1% (70,9% cells viability).**

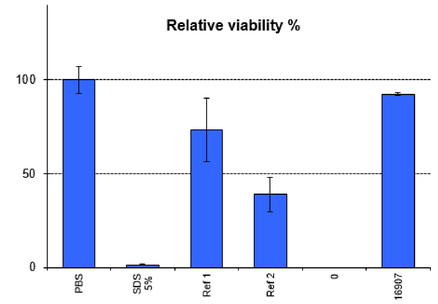


Figure 2. Skin irritation potential of medical device emulsion 16007 tested on EpiDerm model. Ref 1- naphthalene acetic acid (CAS 86-87-3) – non classified (non irritant). Ref 2 - cyclamen aldehyde (CAS 103-95-7) – classified (irritant, Cat. 2). Correlation of in vitro and in vivo results: Tissue viability ≤ 50% of the control (PBS) – irritant (R38). Tissue viability ≥ 50% of the control – non-irritant. **MD 16007 was confirmed as non-irritant on EpiDerm skin model, resulting in the mean tissue viability of 96,3%.**

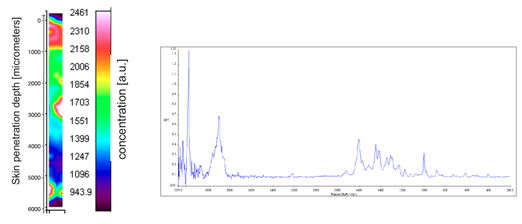
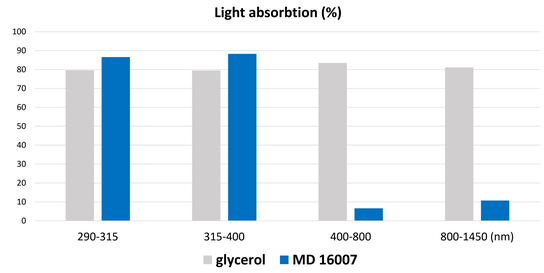


Figure 3. Raman spectrum for MD 16007 and graphic presentation of distribution of emulsion in the inner layers of the skin. Colored scale of correlation level corresponds with the highest intensity of peak characteristic for MD 16007 spectrum. Pink colored spots represent the highest content of the tested emulsion. **Formulation penetrated to the skin in a small level – it is seen only in the upper epidermis.**

Medical Device emulsion	Antioxidant capacity (mg DPPH/ 1g sample)	RPF (10^{18} DPPH/ 1 g sample)
16007	1,35	2,07

Figure 4. RPF value (Radical Protection Factor) was 2,07 x 10^{18} DPPH/1g of emulsion and antioxidant capacity was equal to 1,35 mg DPPH/1g of emulsion.



Wavelenght (nm)	Glycerol	MD 16007
290-315	79,6	**86,6**
315-400	79,5	**88,3**
400-800	83,5	**6,6**
800-1450	81,1	**10,7**

Figure 5. Light absorbtion by MD 16007. Reference sample – glycerol. **Spectrophotometric analysis revealed high UVB and UVA protection (86,6% and 88,3%, respectively) and slight protection against HEV and IR radiation (6,6% and 10,7%, respectively).**

Sample	UVA-PF in vitro (1)	UVA-PF in vitro (2)	UVA-PF / SPF (2)	Critical Wavelength (nm)	SPF in vitro
16007	46.1	49.2	>1/3	> 370 (376)	103

(1) UVA-PF in vitro measured without any pre-irradiation step
(2) UVA-PF in vitro measured after the pre-irradiation step given by the ISO 24443:2011

Figure 6. SPF value of MD emulsion was 103 and ramained stable after 3 months of incubation at 40^0 C. We observed no change in concentration of individual sunscreen agents during the storage time, proving high stability of all the filters.