A global and powerful approach to circumvent harmful effects of blue light and IR-A irradiations on the skin

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INTRODUCTION

It remains in minds that photoprotection is mainly a matter of UV protection. However, all solar radiations lead to the formation of radical oxygen species (ROS) and excess of free radicals in skin contribute to premature skin aging and wrinkling. Visible light and especially high energy visible light (HEVL) notably trigger pro-inflammatory cytokines, different matrix metalloproteinases expression, or oxidation of proteins and these markers all play a role in accelerating skin aging e.g. sagging skin, inflammation, wrinkles and pigmentation disorders. In comparison Infrared (IR) radiation has the lowest energy level but its contribution to the solar spectrum reaching the human skin is about 45% (1). Therefore, the biological impact on the skin may be strong (2). IR light and particularly IR-A induce significant free radicals in the dermis and diminish the skin antioxidant capacity (3) plus at high doses, harmful effects are reported (4). IR radiation has been shown to alter the collagen content of the dermal extracellular matrix (ECM) not only by leading to an increased expression of the collagen degrading enzymes MMPs, but also by decreasing the de novo collagen synthesis (4).

There are already powerful solutions to address light protection beyond UV, notably in the HEV and IR-A ranges, considering the first defense line strategy, meaning avoiding any radiations to enter the skin, and this by using appropriate combinations of specific titanium dioxide UV filters and mica-based functional fillers (5), (6). In this work we present a complementary approach targeting second defense line meaning reducing damages that nevertheless may occur in the skin considering an over-exposure to HEV and/or IR-A radiations.

Ingredients from different origins were selected. 2 ingredients known for their antioxidant properties: a synthetic ingredient: Bis-Ethylhexyl Hydroxydimethoxy Benzylmalonate (HDBM) and a natural extract, Phyllanthus officinalis Emblica Fruit Extract. A natural cell protection ingredient, Ectoin. Validating the link between a first defense line strategy and impact on biochemical markers after a stress to HEV/IR-A was also in focus. Therefore, a 4th ingredient in the form of an emulsion containing a titanium dioxide UV filter grade (INCI: Titanium Dioxide, Silica) was also tested.

The assessment of the protective effect of the different ingredients against HEVL and IR-A radiations was done on living human skin explants. In order to get a comprehensive picture of the mechanism of action and performance of the different ingredients, multiple parameters were tested. Immunostaining of tropoelastin and MMP1 were investigated for explants irradiated with IR-A. For explants irradiated with HEVL, expression of MMP1, 8-OHdG, oxidized protein level, and of Opsin-3 were assessed.
I. Materials and Methods

Products tested

Ectoin (1% in water)

Ectoin was discovered in halophilic bacteria e.g. *Ectothiorhodospira halochloris*, which survive and grow under extreme conditions and high temperatures in salt lakes, saline soils, sea water and saline deserts. Ectoin is a multi-talented ingredient (7), (8). It is a natural cell protection factor showing proven properties like immune system protection, cell protection, complementary UV protection, super moisturizer, anti-aging, anti-pollution, oxidative stress protection.

*Phyllanthus officinalis* Emblica Fruit Extract (Emblica) (0.5% in water)

Emblica is a specific extract based on Indian goose berry tree extracts well-known in the Ayurvedic medicine and obtained from a sustainable source: *Phyllanthus Emblica officinalis* (Emblica). Emblica notably shows outstanding antioxidant properties (9) with excellent singlet oxygen/superoxide anion/hydroxyl radical quenching abilities as well as powerful metal chelating properties (10).

Bis-Ethylhexyl Hydroxydimethoxy Benzylmalonate (HDBM) (1% in ethanol)

HDBM is a powerful antioxidant. It has already be proven to fulfill the necessary condition of high efficacy associated with long-time stability in cosmetic emulsions. It can provide four equivalents of hydrogen for radical scavenging purposes (one phenolic, two benzylic, one malonic). The oxidation product of HDBM itself has antioxidant properties and therefore its activity is maintained over time (11).

Emulsion containing 3% Titanium Dioxide UV filter grade (INCI Titanium Dioxide, silica) (acronym for the rest of the text TDS)

Titanium Dioxide, silica is an inorganic UV-filter, transparent on the skin, with an efficient broad spectrum efficacy in UVA/B range. It also provides a first defense efficacy against HEVL, visible and IR radiations.

Experiments investigating HEVL impact on human skin explants

*Explant preparation*

Human skin explants were prepared on an abdominoplasty from a 45-year-old Caucasian woman (skin phototype II). The explants were kept in survival in a specific culture medium (BIO-EC’s Explants Medium) at 37°C in a humid, 5 %-CO₂ atmosphere.

On day 0 (D0), day 3 and day 4 (before blue light irradiation), the tested products were applied topically. The blank batch did not receive any treatment except the renewal of the culture medium. On day 4, the explants of the concerned batches were irradiated with the Solarbox® blue light using a dose of 84.96 J/cm² for 4 hours.

*Immunostaining of Opsin-3*

Opsin-3 immunostaining was realized on paraffin sections with a polyclonal anti-Opsin-3 antibody. The immunostaining was performed using an automated slide processing system (Autostainer, Dako) and assessed by microscopical observation.

*8-OHdG immunostaining*

8-OHdG immunostaining was realized on paraffin sections with a monoclonal anti-8-OHdG antibody.
The immunostaining was performed manually and assessed by microscopical observation with semi-quantification by image analysis.

**Oxidized proteins immunostaining**

The oxidized proteins were stained on frozen sections after a pre-incubation with DNPH (2,4-dinitrophenylhydrazine, Millipore, ref. 90448) and an incubation with an anti-DNP antibody. The immunostaining was assessed by microscopical observation.

**MMP1 immunostaining**

MMP1 immunostaining has been realized on paraffin sections with a polyclonal anti-MMP1 antibody. The immunostaining was performed using an automated slide processing system (Autostainer, Dako) and assessed by microscopical observation.

**Image analysis method**

The images analyses were performed on all the images of each batch, according to the following method using Cell*D software. For each batch of explants, the percentage of the region of interest covered by the staining (stained surface percentage) is determined by image analysis.

**Statistical analysis**

Statistical analysis was done using Student t-test.

**Experiments investigating Infrared A light (IR-A) on human skin explants**

**Explant preparation**

Human skin explants were prepared on an abdominoplasty coming from a 61-year-old Caucasian woman (Fitzpatrick skin phototype II-III). The explants were kept in survival in a specific culture medium (BIO-EC's Explants Medium) at 37°C in a humid, 5 %-CO₂ atmosphere. On day 0, day 3, day 4 (3 hours before IR irradiation), day 5 and day 6, the tested products were applied topically followed by 10 minutes of drying. The blank batch did not receive any treatment except the renewal of the culture medium. The culture medium was half renewed (1 ml/ well) on day 3 and day 5. Irradiation of the explants were done using an infrared lamp (Dr FISCHER 1000W, 235V 2500K; 760-3000 nm), for 5040s (720J/cm²). Water filter and IR760 filter were also used to have the following IR range 700-1150nm. The explants temperature was measured before and after the IR irradiation. To avoid temperature-driven side-effects, the explants temperature is maintained at 37°C (max 39°C) by specially adapted refreshing system.

**MMP1 immunostaining**: see above in the HEVL section

**Tropoelastin**

Tropoelastin immunostaining has been realized on frozen sections with a monoclonal anti-tropoelastin antibody. The nuclei were counterstained by propidium iodide. The immunostaining was assessed by microscopical observation.
II. Results and Discussion

II.1 Experiments investigating the impact of HEVL irradiation

Opsin-3

Opsins are members of the guanine nucleotide-binding protein (G protein)-coupled receptor superfamily. In addition to the visual opsins, mammals possess several photoreceptive non-visual opsins that are expressed in extraocular tissues. This gene, opsin 3, is expressed in several tissues, including the skin. It has been recently showed that melanocytes sense blue light and regulate pigmentation through Opsin-3 (12).

The HEVL irradiation induced a significant increase of 27%**(p<0.01) Opsin-3 expression in the epidermis vs blank at day 5. The strongest decrease of Opsin-3 after irradiating the explants with HEVL was observed with the explants treated with the 3% TDS emulsion (-37%** vs untreated irradiated explant) (See immunostaining pictures on Figure 2). Moreover, the level of Opsin-3 in irradiated explants treated with 3% TDS emulsion was impacted only in a quite minor way compared to the not irradiated explant treated with the TDS emulsion, also keeping in mind that in basal conditions (blank treated with TDS but not irradiated), opsin-3 levels were decreased. These results show that the TDS emulsion provides a strong protection toward the Opsin-3 sensor after blue light irradiation. TDS is an inorganic material ingredient that prevents/minimizes free radical formation by absorbing, reflecting and scattering properties of solar radiations, thus acting as first defense line. These results well confirm results obtained in earlier experiments showing tremendous first level protection against harmful HELV (5). TDS emulsion provides a physical barrier against HEVL rays and therefore minimize Opsin-3 level changes upon blue light irradiation.

Ectoin was able to decrease Opsin-3 levels by 24% **(p<0.01) after irradiation of the explants to HELV when compared to non-treated irradiated explants. In addition, it is very interesting to notice that in the case of the explants treated with Ectoin, the surface percentage positive to Opsin-3 in the epidermis remained unchanged before and after irradiations with HEVL (see Figure 1). These results also show a strong performance of Ectoin towards Opsin-3 after irradiation to HELV. It is important to remind that Ectoin neither provides a physical barrier nor is an antioxidant.

The natural extract Emblica as well as the synthetic ingredient HDBM were both able to decrease opsin 3- in a more moderate way after irradiation of the explants with HELV (results not shown).

<table>
<thead>
<tr>
<th>Blank (Day 5)</th>
<th>Expant treated with Ectoin (Day 5)</th>
<th>Expant treated with TDS Emulsion (Day 5)</th>
<th>Irradiated non-treated explant</th>
<th>Irradiated explant treated with Ectoin</th>
<th>Irradiated explant treated with TDS emulsion</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average</td>
<td>30.5</td>
<td>28.6</td>
<td>21.8</td>
<td>38.8</td>
<td>29.6</td>
</tr>
<tr>
<td>SD</td>
<td>4.3</td>
<td>5.0</td>
<td>6.8</td>
<td>3.9</td>
<td>2.5</td>
</tr>
</tbody>
</table>

Figure 1: percentage of surface positive to Opsin-3 immunostaining in the epidermis
8-OHdG

Nuclear and mitochondrial DNA oxidation occur most readily at guanine residues due to the high ionization potential of this base. 8-hydroxydeoxyguanosine (8-OHdG) is one of the predominant forms of free radical-induced oxidative lesions in humans (13). The interaction of hydroxyl radicals with the double bond at the C-8 position of the guanine base leads to the production of 8-OHdG. This stable oxidative modified DNA product has extensively been used to reflect the degree of oxidative damage to DNA (14).

On the blank batch 19.6% of the epidermis is occupied by 8-OHdG immunostaining. The different products did not induce a significant change in 8-OHdG levels once applied on non-irradiated explants.

After HEVL exposure, the formation of 8-OHdG is significantly increased by 37% in the epidermis compared to the blank batch and HDBM was able to decrease in a significant way 8-OHdG formation (-17%; p<0.01) followed by Emblica (-15%, significant; p<0.05) and TDS emulsion (-13%; p<0.05).

Emblica notably contains Emblicanin A and Emblicanin B, known to provide long-term and broad anti-oxidative cascade (9). HDBM is well known for its multi-talented oxidant properties (15), (16) and consequently for its ability to prevent premature skin aging signs. Therefore, it explains why both ingredients were able to neutralize the formation of free radicals after HEVL exposure and minimizing thus strong damages to DNA.

TDS providing a physical barrier against the transmission of HEVL light through the human explant, it is clear to understand why it was able to reduce the formation of 8-OHdG after exposure to HEVL.

Due to the fact that Ectoin is not an antioxidant, no effects were expected for this biomarker. Ectoin did not show any decrease of 8-OHdG formation although its performance in protecting against DNA damage on keratinocytes after UVA exposure is known (17).
Oxidized proteins.

The staining of oxidized proteins was realized using the OxyBlotTM protein oxidation kit (Millipore, S7150) on frozen sections. This kit allows the immunoblot detection of carbonyl groups introduced into proteins by oxidative reactions with 2,4- dinitrophenylhydrazine (DNPH), which leads to the formation of a stable dinitrophenyl (DNP) hydrazone product, recognized successively by a specific antibody.

Oxidized proteins were stained in the papillary dermis and the results showed the following results.

The blue light irradiations induce a significant increase of 95%** of oxidized proteins formation in the papillary dermis, in comparison with the blank batch at day 5.

After exposure of the human explants to HEVL, all products were able to decrease in a very significant way the levels of oxidized proteins vs irradiated explant (Figure 4). Results for Ectoin confirm earlier results: Ectoin was shown to reduce carbonyl score and carbonylated proteins expression on HaCat cells and human skin explants after exposure to HEVL light (18). HDBM, Emblica, and TDS were also performant in protecting explants from oxidation of proteins after irradiation to HEVL. It is interesting to note that in basal conditions, Emblica, TDS, HDBM were able to decrease levels of oxidized proteins naturally detectable in the papillary dermis (Figure 3). Therefore, the products all have a protective function of the skin even without HEVL exposure. As written earlier in this manuscript, HDBM and Emblica are both excellent antioxidants and therefore the rationale behind the performance of these ingredients is clear. The TDS emulsion providing a first defense (physical barrier), few proteins from the different layers of the skin explants can be oxidized since the transmission of blue light is drastically reduced. Figure 5 provides typical examples of the oxidized proteins immunostainings.

<table>
<thead>
<tr>
<th>Oxidized proteins variation</th>
<th>Ectoin 0.5%</th>
<th>HDBM 1%</th>
<th>Emblica 0.5%</th>
<th>3% TDS emulsion</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vs blank at day 5</td>
<td>+10% (ns)</td>
<td>-67%**</td>
<td>-85%**</td>
<td>-40%**</td>
</tr>
</tbody>
</table>

Figure 3: Oxidized proteins. Effect of products on oxidized proteins formation in the papillary dermis without HEVL irradiation. ns no-significant; * (p<0.05) ** (p<0.01)

<table>
<thead>
<tr>
<th>Oxidized proteins variation (day 5)</th>
<th>Ectoin 0.5%</th>
<th>HDBM 1%</th>
<th>Emblica 0.5%</th>
<th>3% TDS emulsion</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vs irradiated blank at day 5</td>
<td>-59%**</td>
<td>-42%**</td>
<td>-44%**</td>
<td>-47%**</td>
</tr>
</tbody>
</table>

Figure 4: Oxidized proteins. Effect of products on oxidized proteins formation in the papillary dermis with HEVL irradiation. * (p<0.05) ** (p<0.01). The blue light irradiations induce a significant increase of 95%** of oxidized proteins formation in the papillary dermis, in comparison with the blank batch at day 5.
Figure 5: Oxidized proteins immunostaining. (a) blank after 5 days (b) explant non-irradiated and treated with Ectoin 0.5% (c) explant non-irradiated and treated with Emblica 0.5% (d) explant non-irradiated and treated with HDBM 1% (e) explant exposed to HEVL (f) explant exposed to HEVL and treated with Ectoin 0.5% (g) explant exposed to HEVL and treated with Emblica 0.5% (h) explant exposed to HEVL and treated with HDBM 1%.

MMP1 in the epidermis

The matrix metalloproteinases (MMPs) are a family of peptidase enzymes responsible for the degradation of extracellular matrix components, including collagen I, gelatin, fibronectin, laminin and proteoglycan. HEVL exposure notably induces MMP1 expression inducing MMP1 expression and therefore contribute to signs of premature skin aging (19).

On the blank batch at day 5, 30.9% of the epidermis is positive to MMP1 immunostaining. The irradiation with HEVL induce a significant increase of 77%** of MMP1 expression in the epidermis, vs blank batch at day 5. Impact of the products on MMP1 expression before and after HEVL is shown in Figure 6 and in Figure 7.

<table>
<thead>
<tr>
<th>MMP1 Variation at day 5</th>
<th>Ectoin 0.5%</th>
<th>HDBM 1%</th>
<th>Emblica 0.5%</th>
<th>3% TDS emulsion</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vs blank at day 5</td>
<td>Slight decrease†</td>
<td>+10%ns</td>
<td>No modification†</td>
<td>-22%**</td>
</tr>
</tbody>
</table>

Figure 6: Effect of products on MMP1 expression in the epidermis without HEVL irradiation. * (p<0.05) ** (p<0.01), ns non-significant. † based on immunostaining

<table>
<thead>
<tr>
<th>MMP1 Variation at day 5</th>
<th>Ectoin 0.5%</th>
<th>HDBM 1%</th>
<th>Emblica 0.5%</th>
<th>3% TDS emulsion</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vs irradiated blank at day 5</td>
<td>Slight decrease†</td>
<td>-36%**</td>
<td>Slight decrease†</td>
<td>-20%**</td>
</tr>
</tbody>
</table>

Figure 7: Effect of products on MMP1 expression in the epidermis with HEVL irradiation. * (p<0.05) ** (p<0.01), ns non-significant. The irradiation with HEVL induce a significant increase of 77%** of MMP1 expression in the epidermis, vs blank batch at day 5 † based on immunostaining
HDBM was able to decrease by 36% (p<0.01) MMP1 expression in the epidermis in comparison to the irradiated untreated explant. The strong antioxidant properties of HDBM bring the neutralization of ROS formation after HEVL irradiation and MMP1 expression is therefore minimized. TDS was able to protect explants in basal conditions (without HEVL) and also after irradiating the explants with HEVL. Like for the other parameters we explain this performance by the nature of TDS structure and its ability to reflect, absorb and scatter light. Even if the protection towards MMP1 is partial, a combined protection is measurable both in basal conditions and after a HEVL stress.

The immunostaining also showed that Ectoin had a protecting effect without any irradiation stress and after the HEVL irradiation stress.

Emblica showed a slight protection against MMP1 formation after HEVL irradiation.

II.2. Experiments investigating IR-A impacts on human skin explants

Immunostaining of tropoelastin

Elastin is the major component (90%) of the elastic fibers of the skin (20), (21). It is a protein of the connective tissue responsible for the elastic properties of the skin. It is initially synthesized as its precursor, tropoelastin. The impact of infrared on tropoelastin expression at mRNA and protein levels has been investigated (22), (23). The staining of tropoelastin in the papillary dermis showed the following results.

The IR-A irradiation vs blank at day 7 induced a significant decrease by 45%** (p<0.0001) of tropoelastin expression in the papillary dermis. Additional results are presented in Figure 8 and in Figure 9.

<table>
<thead>
<tr>
<th></th>
<th>Ectoin (0.5%)</th>
<th>HDBM (1%)</th>
<th>Emblica (0.5%)</th>
<th>TDS Emulsion (3%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>tropoelastin Vs blank at day 7</td>
<td>+8%ns</td>
<td>+45%ns</td>
<td>+12%#</td>
<td>-3%ns</td>
</tr>
</tbody>
</table>

Figure 8: Variation of Tropoelastin after application of products vs non-irradiated blank explant at day 7. # p <0.1; * (p<0.05); ** (p<0.01).

<table>
<thead>
<tr>
<th></th>
<th>Ectoin (0.5%)</th>
<th>HDBM (1%)</th>
<th>Emblica (0.5%)</th>
<th>TDS Emulsion (3%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>tropoelastin Vs irradiated blank at day 7</td>
<td>+36%*</td>
<td>+63%**</td>
<td>+79%**</td>
<td>+116%**</td>
</tr>
</tbody>
</table>

Figure 9: Variation of Tropoelastin after application of products after IR-A irradiation vs irradiated blank explant at day 7. * (p<0.05) ** (p<0.01).

Emblica was the only ingredient able to increase significantly tropoelastin expression by 12%# (p<0.1 ) in basal conditions i.e. without any IR-A irradiation. Therefore, Emblica protects the existing elastic fibers in the ECM.

TDS induced the strongest and very significant tropoelastin increase by 116%**(p<0.000) compared to the irradiated non-treated explants. It provides a complete protection of tropoelastin. TDS is an inorganic material ingredient that prevents/minimizes free radical formation through absorbing, reflecting and scattering properties, thus acting as first defense line. These results well confirm results obtained
in earlier experiments showing tremendous first level protection against harmful HELV (5) TDS emulsion provides a physical barrier against HEVL rays and therefore fully protect tropoelastin in the papillary dermis.

Emblica, HDBM, and Ectoin induced significantly tropoelastin expression by respectively 79% (p=0.001), 69% (p=0.000) 63% (p=0.005), and 36% (p=0.015) compared to the irradiated batch and the corresponding pictures for TDS and Emblica are shown on Figure 10. Emblica and HDBM provide a partial and good protection of tropoelastin.

Figure 10: tropoelastin immunostaining. Effect of TDS emulsion (a) blank batch (non-irradiated non-treated) (b) non irradiated batch treated with 3% TDS emulsion (c) non-irradiated batch treated with Emblica 0.5% (d) non-irradiated batch treated with 1% HDBM (e) irradiated non treated batch (f) irradiated batch treated with 3% TDS emulsion. (g) irradiated batch treated with Emblica 0.5% (h) irradiated batch treated with 1% HDBM

MMP1 immunostaining in the epidermis

The matrix metalloproteinases (MMPs) are a family of peptidase enzymes responsible for the degradation of extracellular matrix components, including collagen I, gelatin, fibronectin, laminin and proteoglycan. Matrix metalloproteinase-1 (MMP-1) is an enzyme also known as interstitial collagenase and fibroblast collagenase. It was previously shown that IR-A radiation elicits a retrograde signaling response, which is initiated in the mitochondria through generation of reactive oxygen species (ROS) that originate from the mitochondrial electron transport chain. One major biological consequence of this retrograde signaling response is the increased expression of matrix metalloproteinase (MMP1) (24).

On the blank batch at day 5, 19.6% of the epidermis is positive to MMP1 immunostaining. In basal conditions, the products applied on the explants did not induce any modification of MMP1 expression. The IR-A irradiations vs blank batch induced a clear increase of MMP1 expression in the epidermis (+155% **, p=0.000). 3%TDS emulsion showed the best and strong protective effects against IRA-induced MMP1 expression (decrease of MMP1 expression by 65%**, p=0.000), see Figure 11 and Figure 13) compared to the irradiated untreated batch.

Emblica decreased MMP1 expression in the epidermis by 48%** (p=0.000). HDBM decreased MMP1 expression in the epidermis in a fairly clear way compared to the irradiated untreated batch.
Emblica was earlier shown to be able to decrease MMP1 levels on an in vitro level, and therefore protecting most components of the extracellular matrix (ECM) (25). This result is strengthened by our current result since in presence of an additional stress i.e. IR-A irradiation, Emblica remains able to decrease MMP1 expression. Emblica showing moreover excellent antioxidative properties, it therefore explains its ability to reduce MMP1 expression on the epidermis after IR-A irradiation. A similar conclusion can also be made for HDBM.

<table>
<thead>
<tr>
<th>MMP1 expression in the epidermis</th>
<th>Ectoin (0.5%)</th>
<th>HDBM (1%)</th>
<th>Emblica (0.5%)</th>
<th>TDS Emulsion (3%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weak vs weak: No increase†</td>
<td></td>
<td></td>
<td>+3% ns</td>
<td>+10% ns</td>
</tr>
</tbody>
</table>

Figure 11: MMP1 expression in the epidermis after application of products vs non-irradiated blank at day 5. † based on immunostaining. Statistical analysis: ns: non-significant; ** p<0.01

<table>
<thead>
<tr>
<th>MMP1 in the epidermis</th>
<th>Ectoin (0.5%)</th>
<th>HDBM (1%)</th>
<th>Emblica (0.5%)</th>
<th>TDS Emulsion (3%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Moderate vs fairly clear†</td>
<td></td>
<td></td>
<td>-48%**</td>
<td>-65%**</td>
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</table>

Figure 12 MMP1 expression in the epidermis after application of products vs irradiated blank at day 5. † based on immunostaining. Statistical analysis: ns: non-significant; ** p<0.01

Figure 13: MMP1 immunostaining. (a) blank batch (non-irradiated non-treated) (b) non-irradiated batch treated with 3% TDS emulsion (c) non-irradiated batch treated with 0.5% Emblica (d) irradiated non-treated batch (e) irradiated batch treated with 3% TDS emulsion (f) irradiated batch treated with 0.5% Emblica.
Conclusion

This paper summarized first results (full set of data is still in interpretation phase) investigating the effects of several and different products on human skin explants after irradiation with visible light (HEVL-blue light) and near infrared A (IR-A) light. Ingredients from different origin and different mechanisms of action were selected: a synthetic ingredient with strong antioxidant properties; a natural substance with cell protector properties but without any antioxidant properties, a natural extract with strong antioxidant properties. Validating the link between a first defense line strategy and biochemical markers after a stress to HEV/IR-A was also in focus. Therefore, an emulsion containing a specific titanium dioxide UV filter and therefore providing a physical barrier to IR-A and HEVL rays was also tested. We investigated different biochemical markers typically impacted after an irradiation to HEVL and IR-A.

The selected Titanium dioxide UV filter tested in the form of an emulsion showed after IR-A and HEVL irradiation an excellent protection of all evaluated biochemical markers tested. Therefore, the link between first defense line and biochemical markers is validated. The antioxidant ingredients HDBM also showed excellent performance towards the tested biomarkers followed by the antioxidant natural extract Emblica. It is interesting to note that Ectoin, which neither provides a physical barrier nor is an antioxidant showed a very good protection of the biomarkers after the different irradiations stresses. Further investigations will be done to fully describe the underlying mechanisms of action behind these findings.

Natural sunlight is the main source of HEV and IR-A radiations and defines the probability and frequency of exposure. We need the natural sunlight; however, a protection is necessary. The tested compounds complement both IR and visible light protection on cellular level. According to consumer needs, a large choice of ingredients is now available, either used alone, or possibly in different combinations to protect the skin from negative effects of HEV and IR-A radiations: for instance, a first defense product (TDS product) associated with second defense products (HDBM, Emblica, Ectoin).

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References


