Lipid sensor vesicles in an organotypic model for the assessment of urban exposome induced cell damage and its prevention by skin care products.

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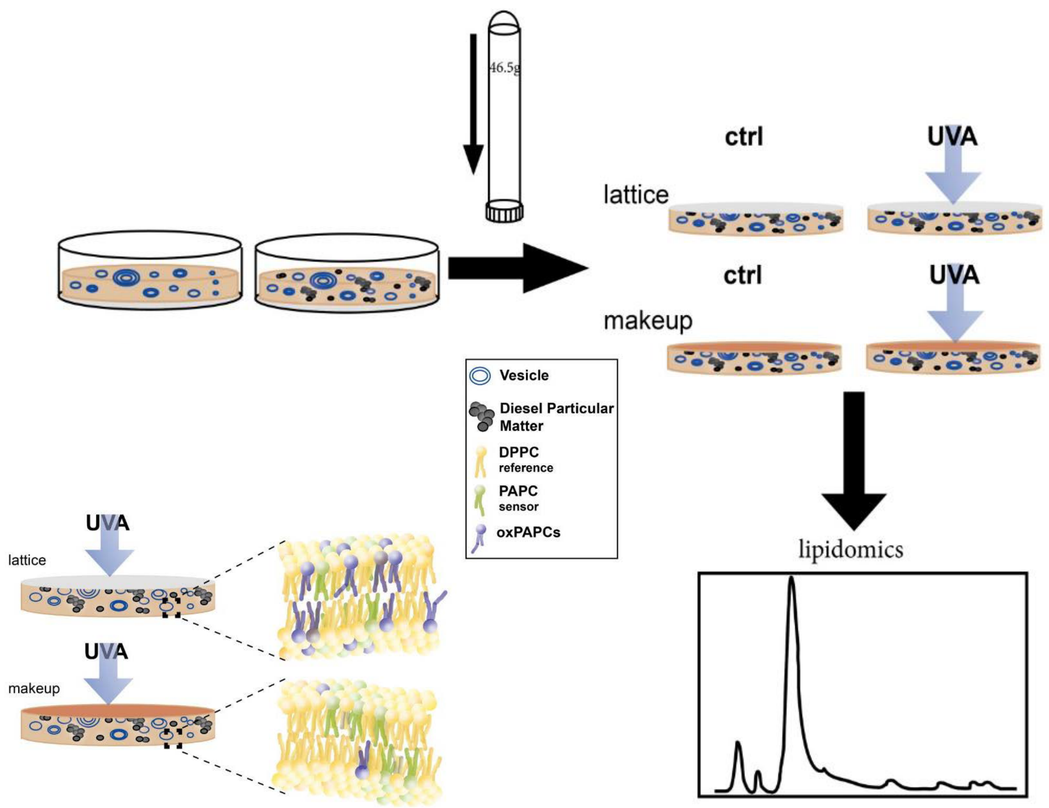
Introduction:

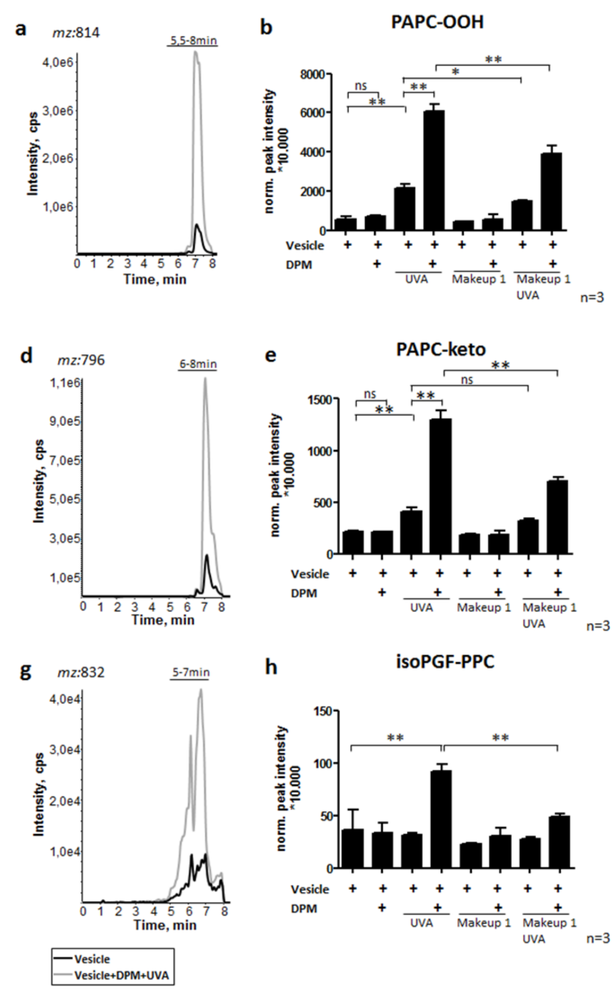
Exposure to sunlight is a main factor for accelerated aging of the skin, especially in synergism with urban and domestic pollution. The mechanisms how pollutants and their combination with solar radiation would promote skin aging are not understood well yet. Urban and domestic pollution exposure promotes parameters of skin aging and tissue damage (Krutmann et al., 2017;Marrot, 2017). Pollution damage is presumed to be amplified by exposure to light from ultraviolet to infrared wavelengths. The damage that has been observed comprises physical oxidative destruction of barrier lipids and oxidative damage to cells in the lower epidermis and dermis. Generation of phospholipid hydroperoxides is regarded as a hallmark of cell- and tissue damaging redox stress in cells and tissues (Thomas et al., 1990), and lipid peroxidation in cells and tissues is performed best by quantifying F2 - Isoprostanes using mass spectrometry (Forman et al., 2015). We here present a mass spectrometry based epilipidomic method to assess a protective effect of skin care ingredients and make-up applied in an organotype, in prevention of pollution/-UV damage to cellular lipids.

Materials & Methods:



Multilammelar vesicles composed of two native membrane lipids (one with unsaturated and oxidizable fatty acid moieties, one with saturated fatty acids) were formulated into a collagen matrix containing diesel particlulate matter. This collagen matrix that mimicked urban pollution exposed cutaneous tissue was covered with a nylon mesh on which the decorative cosmetic formulations were applied. After UV-exposure, the oxidation of the oxidation sensitive lipids in relation to the saturated lipids within the vesicles was quantified with a HPLC/MS-MS based epilipidomic method (Gruber et al., 2012).

Results & Discussion:



UVA exposure alone led to a significant increase in the levels of hydroperoxides of the sensor phospholipid PAPC (PAPC-OOH). In the presence of Diesel Particulate Matter (DPM) the formation of PAPC-OOH was further significantly increased (Figure 1 a, b). PL-OOH can promote the peroxidation chain reaction, thus limiting their generation can limit downstream (per-) oxidative damage. The presence of 6 mg / 3.6 cm² experimental make up formulations “make-up 1” or “make-up 2” on the nylon mesh significantly reduced both the UV - induced lipid oxidation but also the oxidation resulting of the combination of DPM and UV. This was also observed for highly reactive aldehydo-phospholipids (PAPC-keto) and esterified F-isoprostanes which are regarded the gold standard analytes for non-enzymatic redox stress quantification in biological systems.

Conclusions:

Alltogether we were able to identify accumulation of oxidative membrane lipid modifications within these organotypes that were earlier identified in lipid extracts of UV irradiated skin cells (Narzt et al., 2021;Narzt et al., 2019). Presence of reference diesel particulate matter amplified the UV damage. We could apply the tissue model to test whether a commercial make-up preparation would prevent the pollution-amplified damage to the membranes.

This cell free sensor vesicle model can thus be used to perform basic research on pollutant mediated lipid photooxidation but also to test whether cosmetic or skin care products can prevent the synergistic damage exerted by UV radiation in combination with pollution.

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