Deschampsia antarctica as a novel skin protection tool against environmental pollution

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INTRODUCTION

The skin is the largest organ of the human body and constitutes the most external and essential defensive barrier against pathogens and physical-chemical damage involving thermal deregulation, dehydration, chemical attack and ultraviolet radiation. To deal with these critical challenges, the skin exhibits a high self-renewal potential driven by dynamic stem cell niches. However, the cutaneous homeostatic and regenerative potential is at present critically impaired by the increasing accumulation of several air pollutants, directly implicated in a plethora of dermatological conditions, including premature skin ageing, altered pigmentation and cancer. In this scenario, innovative strategies are required to tackle the effects of severe air pollution on skin function.

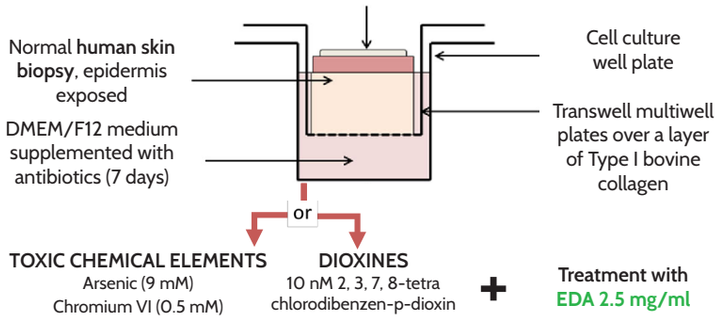
Deschampsia antarctica is a polyextremophilic Gramineae native to Antarctica that lives in extreme conditions due to unique molecular and evolutionary mechanisms that provide highly efficient protection against environmental aggression. Aqueous extract of Deschampsia antarctica (EDA) is presented as an innovative strategy against the effects of severe air pollution on skin function.

OBJETIVES

To **investigate** the **potential protective effects** of EDA after exposure to common and massive chemical contaminants in a Human Skin Organ Culture (HSOC) model.

MATERIALS AND METHODS

In **Human Skin Organ Culture (HSOC)**, as experimental model, we have investigated the potential protective effects of EDA after exposure to common and massive chemical contaminants.



1st PHASE

For the generation of HSOCs, human skin samples obtained from surgical skin remnants were cut in 50-70 mm2 pieces and cultured in Transwell multiwell plates over a layer of Type I bovine collagen.

2nd PHASE

Histological sections

Skin samples were fixed in 4% buffered formaldehyde (pH 6.8), embedded in paraffin and sequentially sliced into 8 µm sections.

Histological Assessment: H&E

Immunolocalization analysis

Immunohistochemistry:

- ECCD1
- Ki67
- TUNNEL assay

RESULTS

PROTECTION AGAINST SEVERE MORPHOLOGICAL DAMAGE INDUCED BY CHEMICAL POLUTANTS

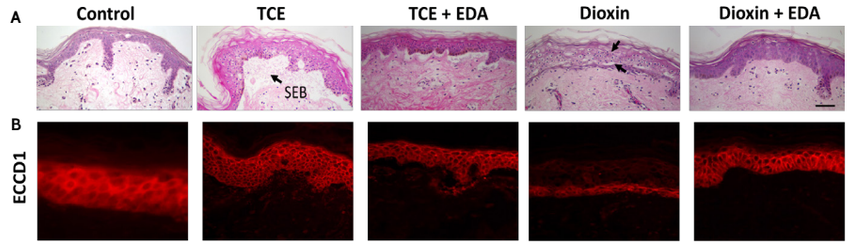


Figure 1. Histological sections of human skin samples stained with H&E **(A)** or processed for immunolocalization of the epithelial cell-cell adhesion molecule E-cadherin (ECCD1) **(B)**. Bars: 50 µm.

Figure 1A shows the severe morphological alterations induced in human skin samples by prolonged exposure to common air pollutants, including Toxic Chemical Elements (TCE: As + Cr) and dioxins. Both TCE promote a massive subepidermal blister (SEB, arrows), while exposition to dioxins causes a huge disorganization of epidermal layers (arrows). These alterations, indicative of a critical loss of function in the skin, are efficiently prevented by EDA.

Immunolocalization of the epithelial cell-cell adhesion molecule E-cadherin (ECCD1; Figure 1B), confirms the complete structural disorganization of suprabasal epidermal layers induced by dioxin exposure, and the protective effect of EDA treatment.

INDUCTION OF CELL PROLIFERATION IN THE SUPRABASAL EPIDERMAL LAYER

Representative images of the cell proliferation marker Ki67 immunolocalization in histological sections of human skin samples grown for 7 days in different experimental conditions are shown in Figure 2. A basal number (15-20%) of proliferating cells (arrowheads) in the basal layer of the epidermis is observed in Control conditions, which is considerably increased (55-60%) after EDA treatment. Interestingly, no proliferating cells are detected in skin samples grown in the presence of TCE or dioxin, a condition prevented by EDA treatment.

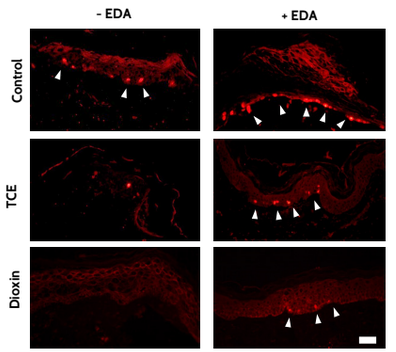


Figure 2. *Immunolocalization of the cell proliferation marker Ki67 in histological sections of human skin samples. Bar: 50 µm.*

PREVENTION OF DNA FRAGMENTATION INDUCED BY CHEMICAL POLUTANTS

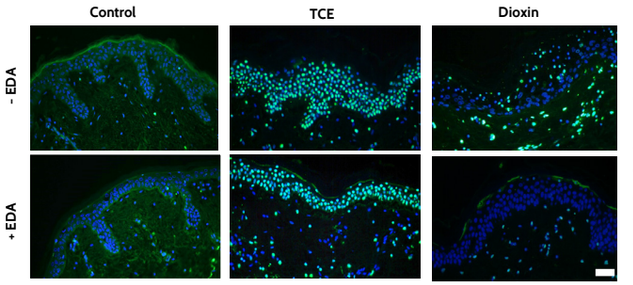


Figure 3. *DNA fragmentation pinpointing , evaluated by the TUNEL assay, in histological sections of human skin samples. Bar: 50 µm.*

EDA prevents the DNA fragmentation induced in human skin after prolonged exposure to dioxin. Representative images of DNA fragmentation, evaluated by the TUNEL assay typically used for detection of apoptotic cells, in human skin samples grown for 7 days in different experimental conditions are shown in Figure 3.

CONCLUSION

Aqueous extract *Deschampsia antarctica*, also called EDAFENCE, exhibits a significant global function against chemical pollutants in the HSOC model, suggesting that this natural extract might be effectively used in vivo to protect human skin routinely in different daily conditions. We have identified three ways by which EDA may have significant biological effects in the context of continuous ambient pollutant exposure: **Prevention and protection against of severe morphological alterations and irreversible DNA degradation**; and Induction of cell proliferation in the basal layer of the epidermis. All these aspects deserves further investigation to dissect the underlying molecular mechanisms by which EDA exerts its protective effects in human skin.

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