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in vitro photoprotective effect of optical filters on retinal pigment epithelium cells exposed to moderate daylight-mimicking conditions

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INTRODUCTION

Blue light is an accelerating factor in retinal ageing and a contributing factor in age-related macular degeneration. We recently identified **415-455 nm** as the most toxic band within the blue wavelengths for the retinal pigment epithelium (RPE) cells (Arnault *et al*. 2013, Marie *et al*. 2018).

We here investigated the ***in vitro* photoprotective effect** of **optical filters** designed to **specifically block** between 20 and 70% of this toxic band, including a Smart Blue Filter. We compared their protection with a **broadband dark-yellow** filter.

We aimed at defining a blue-violet filtering level allowing a **significant photoprotection** level by an **aesthetic spectacle lens**.

MATERIALS & METHODS

Primary swine RPE cells were loaded with 20 µM of A2E, a major chromophore of lipofuscin, to mimic retinal ageing. Cells were then **exposed during 18 hours to a purpose-made light device that delivered 1.8 mW/cm² of daylight spectrum within the visible range 380-600 nm** weighted by the eye media filtering.

Filters were interposed between the retinal cells and the light source to evaluate their *in vitro* protection potency against light-induced cell damage.

Apoptosis and accumulation of hydrogen peroxide (H2O2) were measured after a rest period or at the end of light exposure.

RESULTS

In A2E-loaded RPE cells, mimicked-daylight at moderate irradiance **increased apoptosis by 2.7 and H2O2 by 4.8** compared to the dark control.

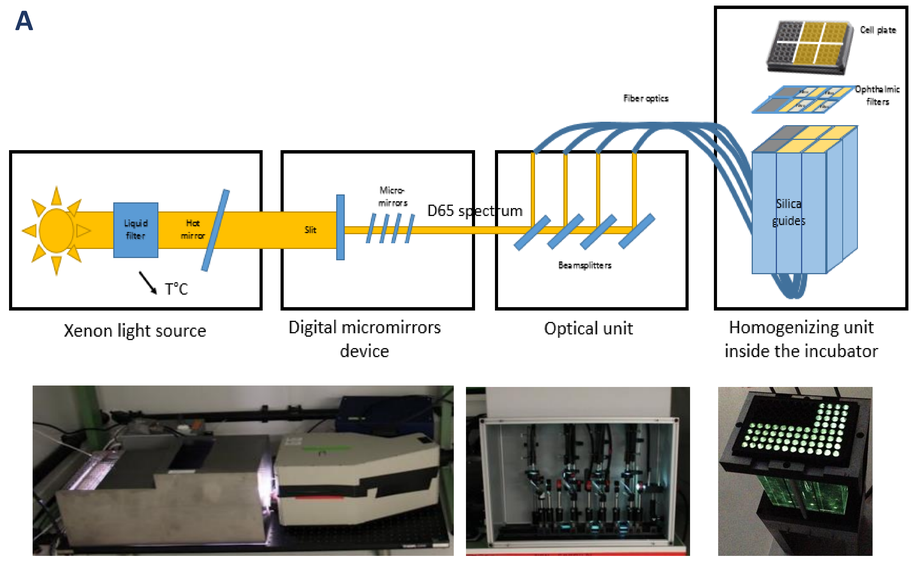
The **20% blue-violet filtering** Smart Blue Filter was able to decrease **light-induced cell apoptosis** by up to **40%** and **H2O2** (oxidative stress) by **25%**.

Cutting **70% of 415-455 nm** while letting pass the other portions of blue light (Filter 3) decreased **apoptosis by 70%** and **H2O2 by 60%**. This *in vitro* protection was closely comparable to the one conveyed by a conventional broad dark-yellow filter.

CONCLUSION

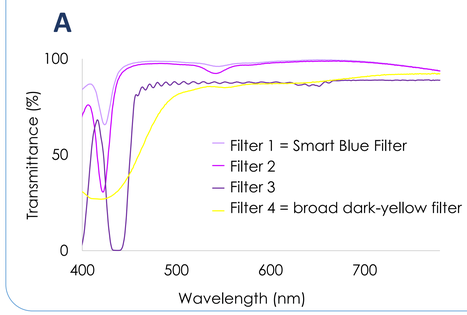
The results on narrow-band filters versus the broadband yellow one confirmed the major contribution to phototoxicity of the 415-455 nm band and helped us to design a lens with adequate trade-off between aesthetics and significant *in vitro* photoprotection.

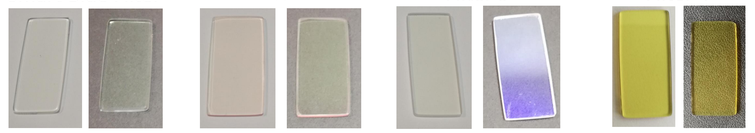
1- Custom-made spectrally adjustable light device & cellular model



A. Tailor-made spectrally adjustable device. A high power Xenon light source is custom-adjusted in spectrum and light level in the visible range through a digital micromirrors unit. The light output is equally divided in 4 channels. Each channel passes through a homogenizing unit to illuminate 16 wells (35x35 mm²) of a 96-well plate. The filters are placed between the well-plate and the light comparable to glasses placed between the light environment and the eye.
B. Daylight-mimicking (D65), 1.8 mW/cm² over 380-600 nm, during 18 hours
C. Confocal imaging of A2E accumulation in RPE cells. Blue: nucleus, green: A2E, red: tight junctions.

2- Optical filters



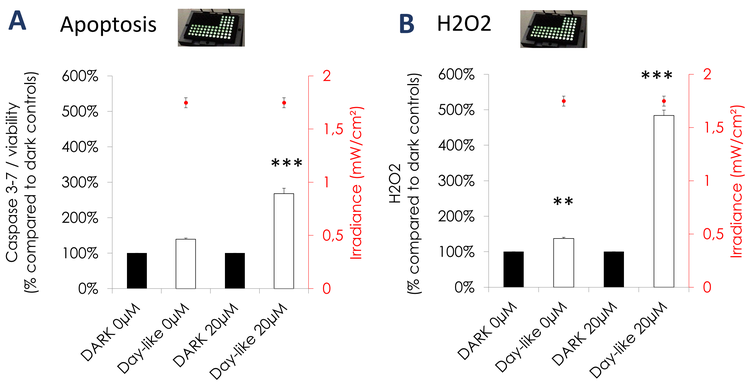


C

	Smart Blue Filter	Filter 2	Filter 3	Filter 4
CUT 415-455 nm (%)	20% Narrow-cut	30% Narrow-cut	70% Narrow cut	68% Broad cut 380-500 nm
b* 10° CIE L*a*b 1976	3	7	30	35
Aesthetics	+++	++	+	- -

A. Spectral filtering profiles of lenses over the visible range
B. For each filter, photo on a white background (left) or a black background (right).
C. Compared characteristics of filters: blue-violet light cut within 415-455 nm *(the higher, the better),* yellowness (b*) *(the lower, the better)*

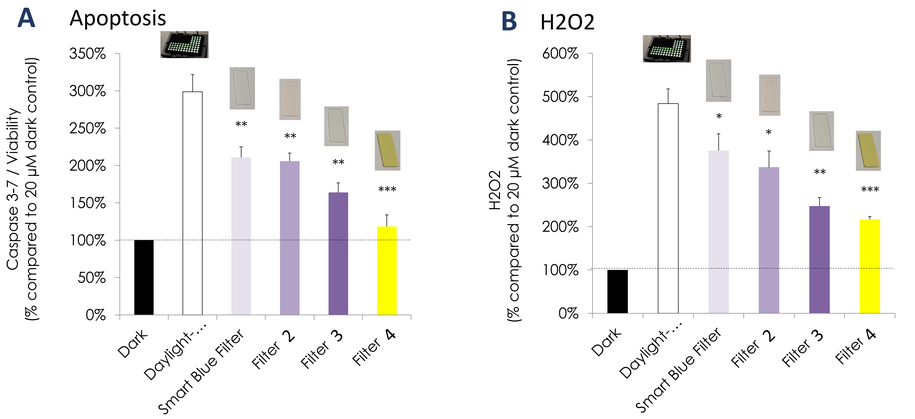
3- Damage induced by mimicked-daylight in a retinal ageing cell model



A. Light-induced apoptosis in day-like conditions: x 2.7
B. Light-induced H2O2 in day-like conditions: x 4.8

One-factor ANOVA, post-hoc Dunnett compared to each dark control (p<0.05)

4- *in vitro* photoprotection potency of filters



A. Caspase 3-7/viability rate was decreased by 40% with the Smart Blue Filter and by 70% with Filter 3.
B. H2O2 was reduced by 25% with the Smart Blue Filter. Filters 3 and 4 similarly reduced H2O2 (60% protection).

One-factor ANOVA, post-hoc Dunnett compared to day-like condition without any lens (p<0.05)

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