A combination of honey to repair Asian hair from UV-A and environmental pollution-induced damage

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INTRODUCTION

Medicine with natural bee-derived products is getting more and more attention and each bee product possesses specific components which determine their activities. Like skin, hair is exposed to UV and pollution causing damage which lead to porous, dull and brittle hair. To investigate honey care activities on hair integrity, porosity and surface roughness, we studied hair repair properties of a combination of 4 honeys from Ouessant, Corsica, Aland and Ikaria islands against a stress generated by UV-A exposure plus urban pollution. The use of two technologies in association allowed to have an in-depth study of hair repair. Asian hair shafts were stressed before application of our honey combination and then washed and dried. For assessing porosity and integrity, hair shafts were labeled with fluorescein solution and cross-sections studied with epi-fluorescent microscope and image analysis. For cuticule roughness evaluation Kamax 3D-XFluo® technology has been used. Hair shafts were labelled with fluorescein and imaging by confocal microscopy was performed. Tomograms were acquired as multiple stacks and computed together to generate 3D images allowing visual appearance assessments and surface roughness measurements.

MATERIALS AND METHODS

Sample preparation and product application

Asian hair strands used in this study were obtained from a Chinese female donor, free from chemical treatment and significant physical damage. Hair shafts were stressed with PM-10 (150 µg/cm^2; ERM-Z100) + UVA-irradiation (365 nm; 84J/cm^2) and then treated with the honey combination for 1 hour followed by a washing step with ultrapure water and natural air drying.

Structural integrity and porosity

Hair shafts were dipped in fluorescein solution, rinsed, sampled and cryopreserved (in OCT), snap-frozen and kept at -80°C until analysis. Hair shaft 5 µm cross-sections were prepared and fluorescent images were collected in a range of intensity of specific signal with an epi-fluorescent microscope) and analysed with Image J software.

An efficacy value (%) was obtained for the experimental groups accordingly to :

$$\text{Efficacy \% (group } X) = \frac{\text{Fluorescence intensity (Stress)} - \text{Fluorescence intensity (group X)}}{\text{Fluorescence intensity (Stress)} - \text{Fluorescence intensity (Control)}} * 100$$

As references, the control group is considered at 100% efficiency and the stress group at 0% efficiency.

Hair surface roughness

Hair shafts were prepared for analysis by fluorescence confocal microscopy measuring the surface roughness thanks to fluorescent staining (3D XFluo® technology). The object tomogram is acquired as multiple thin sections or stacks that are computed together to generate a 3D image (reconstructed from 200 stacks, each of them separated from 85 nm. From 3D view, Kamax assessed the visual appearance and measured the surface roughness.

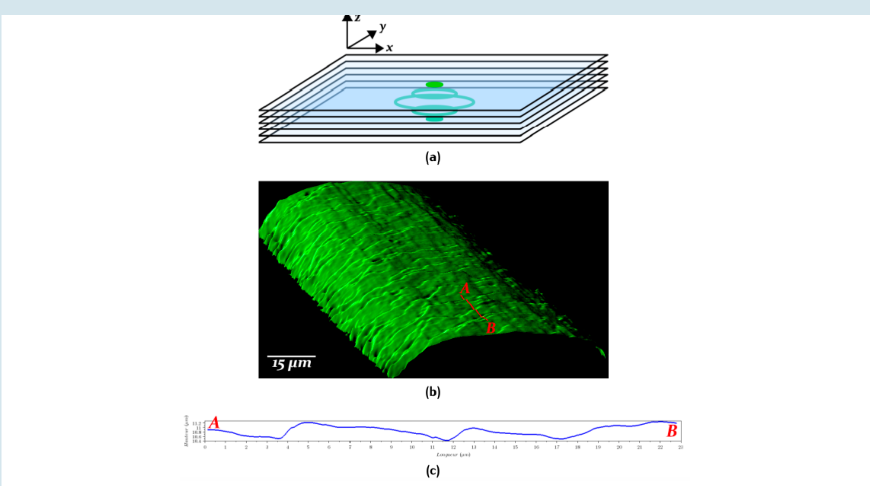

Figure Example. (a) Scheme of stacks - thin sections - obtained from the tomogram of a fluorescent object (green ellipsoid). (b) Example of surface roughness measured from stained hair cuticle with fluorescein. (c) Measure of roughness from A to B section in (b)Rq = 0.20 µm.

3D images (Figure Example) were obtained representing the surface of each single hair segment stained with fluorescein. From 3D views, the visual appearance were assessed and the surface roughness measured as follow. From the hair surface (Figure Example (b)), a section on top of the hair is drawn (Figure Example (c), point A to B) that allows to measure the roughness (in this example, Rq = 0.20µm).

CONCLUSION

Hair damage leads to porous, dull and brittle hair. We studied hair repair abilities of a combination of 4 honeys from Ouessant, Corsica, Aland and Ikaria islands against UV-A exposure plus urban pollution. These two innovative technologies, combining visual and quantitative observations, allowed an in-depth study of hair repair considering hair integrity, porosity and surface roughness. The honey association allowed to repair by 54% the integrity and the porosity of Asian hair shafts and by 61% the surface roughness from the aggression leading to strengthened, soft and shiny hair.

RESULTS

Hair integrity and porosity : in situ fluorescein penetration quantification

Condition	Dye penetration (%) mean	Standard deviation	Efficacy (%)	Significance (vs Stress)
Control	1%	1%	100%	* * *
Stress	23%	1%	0%	-
Stress+ honey combination	11%	2%	54%	* * *

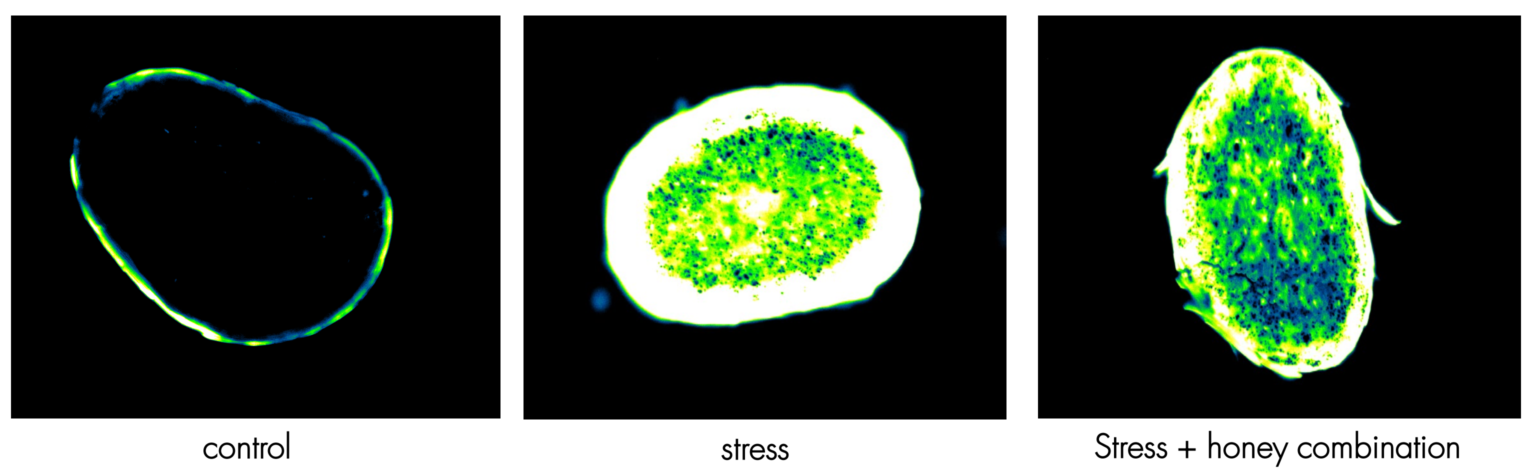

Figure 1: *In situ* visualization of fluorescein diffusion on cross-section of hair. The fluorescence emission signal for fluorescein was obtained by using specific excitation and emission wavelengths (498/517 nm).

→ by decreasing hair porosity, the honey combination allowed to repair hair by 54%.

Hair Surface Roughness : fluorescence confocal microscopy

Condition	Roughness parameter (Rq) mean (µm)	Standard deviation	Efficacy (%)	Significance (vs stress)
Control	0.145	0.029	100	* * *
Stress	0.205	0.041	0	-
Stress + honey combination	0.169	0.034	61%	* *

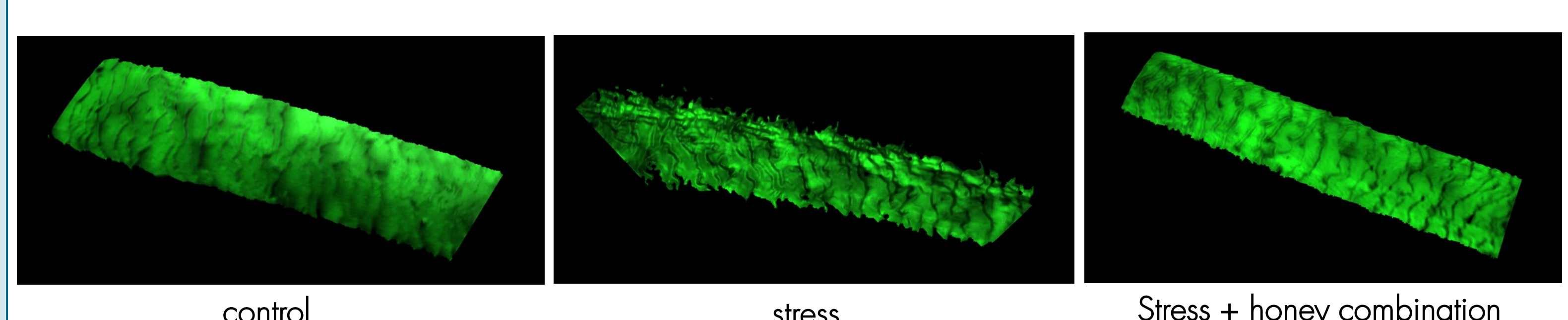

Figure 2: XFluo® analysis. Representative images of reconstructed hair segment

→ 3D image reconstructions and measurements of roughness parameters demonstrated the repair of hair surface by 61% exerted by the honey combination.

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