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Breakthrough on hyaluronic acid penetration inside hair fibres and keratin interaction for a smoothing effect explained

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Introduction:

Keratin plays an important role for the physical and mechanical properties of the hair and is mainly found in an α-helix conformation coiled by disulfide bounds. Conversely, a β-sheet conformation decreases the formation of disulfide bonds and lead to a smoother hair fibre. Modifying keratin conformation is a key mechanism used by the haircare industry to shape and straight the hair but current chemical agents damaged it[1]. Hyaluronic acid (HA) is a key active ingredient in skincare but its benefits for the hair has been poorly described. The interaction between HA and keratin has only been described in the *stratum corneum* of the skin and no evidence of an interaction inside the hair has been established yet[2]. Indeed, exploring penetration of molecules through the hair fibres presents some challenges. Different techniques, including confocal fluorescence microscopy, have been used for examining the penetration of tagged molecules but hair auto fluorescence compromise the results[3]. Besides, due to the hair fibres cuticle, only low molecular weight molecules have been described, so far, to be able to penetrate the cortex[4]. In this work, we developed an efficient non-invasive methodology to follow for the first time the penetration of HA through normal or UV-induced damaged hair using Raman spectroscopy. We then developed an optimized HA blend between low molecular weight (LMW) and high molecular weight (HMW) HA dedicated to haircare application based on optimal hair penetration. Once into the cortex, this optimal HA-Blend interacts with keratin to change its conformation in favor of β-sheet conformation for a visible smoothing effect.

Materials & Methods:

Natural hair locks washed with actives

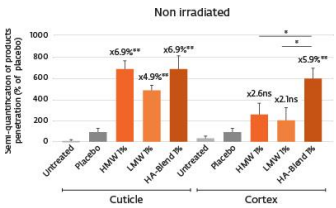
HA penetration by Raman spectroscopy
The spectral acquisitions were recorded all along the hair fibre with a scanning Z step size of 3 µm.

Keratin conformation by Raman spectroscopy
Based on a cluster analysis that allows the classification of hair fibres with a similar keratin structure.

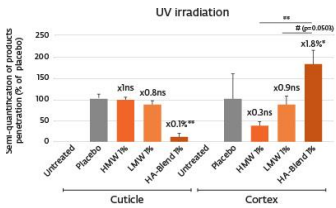
Anti-frizz *ex vivo* analysis
Curly hair locks were put in a room under extreme conditions of humidity (Relative humidity 80% ± 10% RH) during eight hours.

Results & Discussion:

1. Penetration of HA through non-irradiated hair fibres

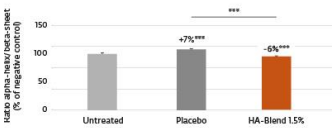


2. Penetration of HA through irradiated hair fibres with UVA and UVB



3. Impact on the α-helix/β-sheet ratio after washing with shampoo at 1.5% of the HA-Blend

The HA-Blend significantly reduce the α-helix /β-sheet ratio by 13% in comparison to the placebo.



The penetration of the optimal HA-blend shampoo inside the cortex is significantly higher than the HMW or the LMW HA shampoos, both in undamaged or UV-induced damaged hair fibres by 5.9 and 1.8 times respectively.

4. Anti-frizz effect after washing with shampoo at 3% of the HA-Blend.

The HA-Blend at 3% has a visible anti-frizz effect after 8 hours in extreme humidity condition and smoothed the hair by 11% in comparison to the placebo.

Conclusions:

In this work, we demonstrated that an optimized formulation between different molecular weight HA was able to deeply penetrate the hair cortex to interact with keratin and change its conformation to smooth the hair. To the best of our knowledge, this study is the very first to prove and compare the penetration of different molecular weight hyaluronic acid inside hair fibres. Confocal Raman spectroscopy can be considered as a powerful and non-invasive technique for investigating the penetration of hair cosmetic ingredients in human hair fibres. This insight opens new doors for the haircare industry to understand the mechanism of action of active molecules for hair benefits.

Acknowledgements:

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