Damage limitation: comparing the impact of polymers on bleached hair when applied during or as a post-bleach treatment

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Introduction and aim of the project

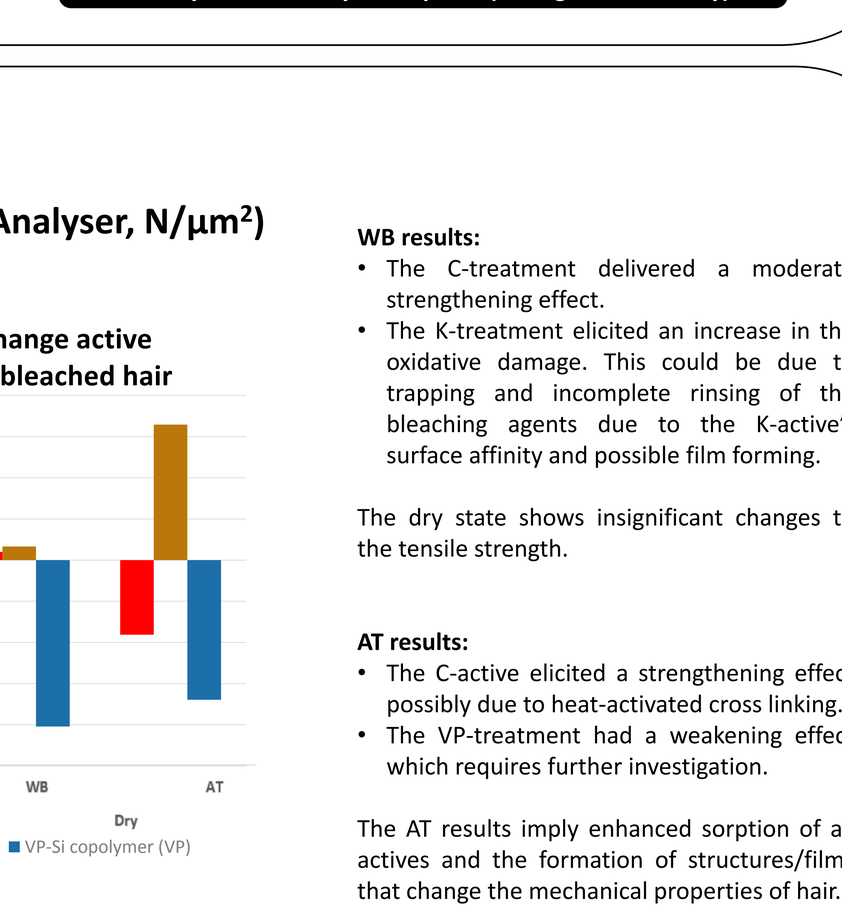
Hair bleaching causes undesirable chemical and structural changes to the cortex, the most prominent process being the oxidation of the disulphide bonds of the amino acid cystine and the creation of cysteic acid [1]. It is known that this process affects mostly the Keratin Associated Proteins (KAP) which are amorphous and sulphur-rich. A major secondary effect is the overall destabilisation of the cortex structure within which the crystalline Intermediate Filaments' (IF) proteins are supported by KAP. An overall decrease in the proportion of ordered protein structure [2], reduction of mechanical strength [3] and the denaturation temperature of hair [4] have been used to quantify the degree of damage. The cuticle also undergoes oxidative damage during bleaching which causes reduced thickness and increased surface roughness [5].

Mitigating and counteracting these changes in the hair surface and internal structure have been a prime objective of the haircare industry. Such action would be expected to deliver immediate sensory benefits perceivable by the consumer.

The aim of this project was to compare the impact of three actives said to deliver structural benefits to bleached hair. Their impact was evaluated in two conditions: when applied with the bleaching cream (WB) and after bleaching (AT).

Materials and methods

K: Hydrolysed keratin (Aver. Mw=1800)
C: Cystine/silanol copolymer (Aver. Mw = approx. 20000)
VP: Hydrolysed vegetable protein/silanol copolymer (Aver. Mw=1000)
DB: Double bleached hair (control)



Results and discussion

Colour measurements (Konica Minolta, CIE L*a*b*)

L (WB) > L(DB) and b (WB) < b (DB): All WB hair was lighter and less yellow than DB
L (AT) > L(DB) and b (WB) < b (DB): All AT hair was lighter and less yellow than DB

Colour analysis: WB and AT treatments enhanced melanin oxidation, as all L-values increased and all b-values decreased in comparison with DB hair (control) ($p<0.05$).

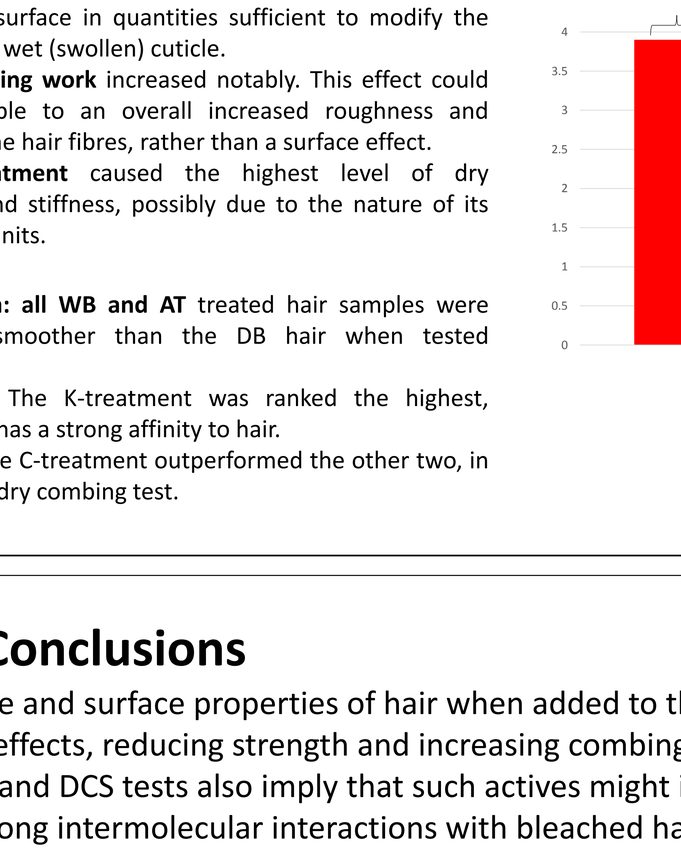
Differential Scanning Calorimetry (Multi Cell DSC, Denaturation Temperature Td °C)

Treatment name	Temperature of denaturation °C	
	WB	AT
Keratin treatment	119.04	117.05
Cystine- Si treatment	119.04	119.04
VP-Si Coplymer treatment	119.04	115.05
Double bleached hair	124.04	
Virgin hair	142.03	

- **WB DSC analysis** suggests that the bleach moderates the sorption of the actives.
- **AT DSC analysis** suggest that, when applied after bleaching, the actives are more likely to interact with the hair.

We suggest that the actives reduce the Td of bleached hair either via causing an entrapment of bleach components, thus prolonging the bleaching process, and/or via their direct interaction with the hair.

Tensile strength (Texture Analyser, N/µm²)



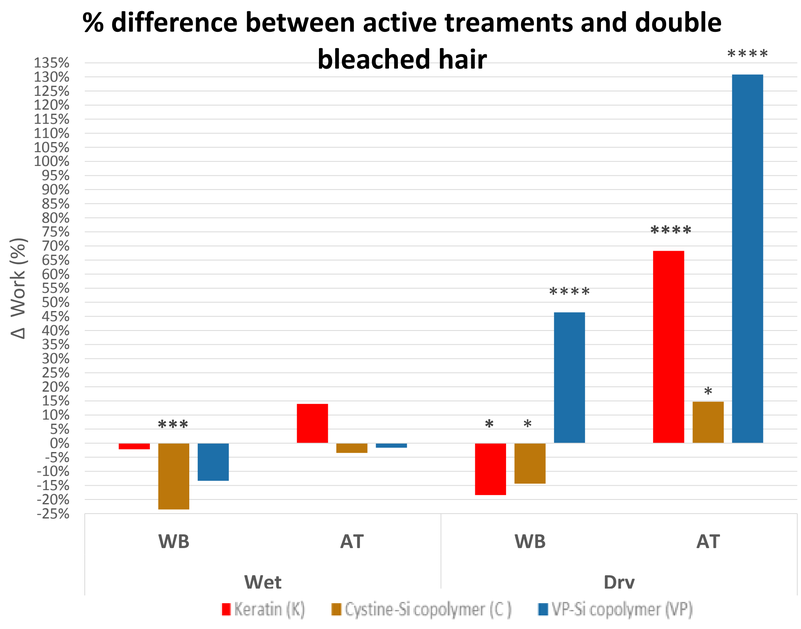
WB results:
- The C-treatment delivered a moderate strengthening effect.
- The K-treatment elicited an increase in the oxidative damage. This could be due to trapping and incomplete rinsing of the bleaching agents due to the K-active's surface affinity and possible film forming.

The dry state shows insignificant changes to the tensile strength.

AT results:
- The C-active elicited a strengthening effect possibly due to heat-activated cross linking.
- The VP-treatment had a weakening effect which requires further investigation.

The AT results imply enhanced sorption of all actives and the formation of structures/films that change the mechanical properties of hair.

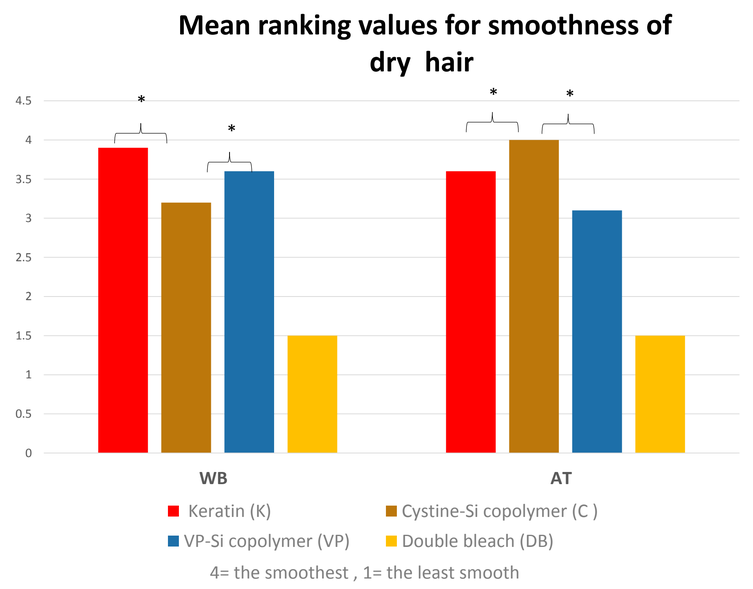
Work of combing (Texture Analyser Nm)



Combing data:
- **WB results.** C-treatment conditioned the hair (wet and dry), reducing the work of combing. This impact is partly mirrored by the K-treatment (dry).
- **AT wet combing** implies that the actives were not present on the hair surface in quantities sufficient to modify the profile of the wet (swollen) cuticle.
- **AT dry combing work** increased notably. This effect could be attributable to an overall increased roughness and stiffness of the hair fibres, rather than a surface effect.
- **The VP-treatment** caused the highest level of dry roughness and stiffness, possibly due to the nature of its protein sub-units.

Sensory data: all WB and AT treated hair samples were statistically smoother than the DB hair when tested sensorialy.
WB results: The K-treatment was ranked the highest, suggesting it has a strong affinity to hair.
AT results: the C-treatment outperformed the other two, in line with the dry combing test.

Sensory test (12 trained assessors x 3 tests)



Conclusions

In summary, the C-active presented some potential to enhance the tensile and surface properties of hair when added to the bleaching cream and as an after treatment. Under the test conditions, the K and VP treatments showed undesirable effects, reducing strength and increasing combing work, but offered sensorial benefits. Their use levels require adjustment to ensure a balanced outcome. The colour and DCS tests also imply that such actives might influence the oxidative process, either directly or via trapping the bleaching agents in the cortex, and that they have strong intermolecular interactions with bleached hair. Hence, the use of such actives would require a complex formulation approach.

References :
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