An ex vivo comparative study of the tensile strengthening efficacy of protein-derived actives on heavily bleached hair

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Introduction

Chemical hair lightening remains a current fashion and beauty trend which shows no signs of decline. However, consumers are often distressed to discover that the quality of their hair has been significantly impaired by the harsh chemical process, with breaking prove to be a major source of concern. Whilst conventional conditioning agents effectively manage cuticular damage, the reversal of cuticular weakening of hair poses a greater challenge. Protein-derived actives have been shown to confer cortical strengthening by improving axial strength and elasticity of hair fibre [1]. For example, Roddick-Lansellota et al. [2] have shown significant improvement of tensile strength of permmed hair by conditioner formulations containing 1% and 3% of collagen hydrolysed combined with glycoproteins. Schulz-Zur Wiescha et al. [3] investigated a new keratin active derived from a microbial "low-sulfur" cortex keratin of wool and demonstrated that the active effectively reduces the aging effects on the human hair structure. However, the molecular features important in mediating the repairing responses remain unclear.

Materials and Methods

Formulae:
A hair conditioning cream containing cetetaryl alcohol, paraffinum liquidum, glycol distearate, steareth-21, glycerine, water and preservatives was formulated as a vehicle for the protein-derived actives. The pH was adjusted by citric acid solution to 4 – 6 after incorporation of active ingredients. Investigational protein derivatives were: hydrolysate of wheat protein (WHP), L-arginine (Arg) and hydrolysed collagen (HC). Each active ingredient was incorporated at five concentrations: 1, 1.25, 5, 10 and 12.5% (w/w as supplied), in order to establish the concentration-response profiles.

Hair substrate:
Caucasian hair tresses from the same head, approximately 13 cm in length and 4.4g in weight were used. Tresses were bleached at 12% H2O2 for 90 minutes and rinsed for 3 minutes under running water at 40°C. Further, bleached tresses were blow-dried at 50°C for 5 minutes, with combing at an approximate rate of 60 strokes per minute. Once dried, tresses were further damaged using ceramic straighteners at temperatures of over 180°C, for 5 minutes at a rate of 6 strokes per minute.

Hair treatment:
The treatment method of tresses with conditioner was as follows (method adapted from Assmus et al [4]):

- Bleached and groomed hair tresses were washed for 5 minutes with 8% sodium lauryl ether sulphate and rinsed for 3 minutes with water (ca. 40°C).
- Tresses were treated with conditioner formulation, using 1g/l of hair, and massaged for the required period of time without combing.
- Tresses were rinsed for 3 minutes with water (ca. 40°C) and finger-squeezed dry.
- Wet instrumental measurements were carried out.
- Tresses were dried with a hairdryer at 50°C for 5 minutes without combing.
- Dry instrumental measurements were carried out.

Results and Discussion

Tensile strength of control hair tresses:
As expected, intensely bleached tresses were weaker than virgin hair. Two-way ANOVA revealed a highly significant difference (p<0.0001) between the tensile strengths of wet and dry bleached hair. In the wet state, bleached hair was on average 13.8% weaker (p=0.001), while in the dry state it was approximately 35% weaker (p< 0.02). Overall, the findings provided confidence in the tensile testing method and established the upper and lower test limits for the virgin and bleached tresses, respectively.

Concentration response of 60-min treated hair tresses:
The results for the wet fibre tensile break strengths are presented in Figure 2a, whilst the dry results are presented in Figure 2b.

Figure 2. Tensile strengths of active-treated bleached hair in the wet state (a) and dry state (b) as a function of concentration (n=6, 60 minutes treatment)

Figure 3. Tensile strengths of active-treated bleached hair in the wet state (a) and dry state (b) as a function of time (n=6)

Conclusion

Overall, the most efficacious of the protein-derived actives, taking into account both wet and dry tensile strengths, was found to be hydrolysed wheat protein (p<0.0001), closely followed by hydrolysed collagen (p=0.011). L-arginine did not significantly improve overall tensile strength versus bleached control tresses. It is suggested that the mechanism of action in conferring tensile strengthening properties to damaged hair fibres involves the substitution of hydrogen and electrostatic bonds in the cortex.

Acknowledgments

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References