Comparing Protective Pre-treatments for African Hair

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Introduction

African and very frizzy hair is characterised by low manageability and often described by consumers as dry. As a result, hair is washed less frequently, and hairstyling involves techniques and materials aimed at improving fiber alignment. Thermal styling with appliances reaching T>200ºC improves hair alignments and manageability but has been shown to cause changes to the chemical composition of proteins in the cortex, as well as cuticle cracking due to trapped water. Such damage is compounded by mechanical forces during grooming, surfactants and regular exposure to solar radiation. Mitigating or compensating for these effects is achieved by using polymers which cause more efficient heat distribution along the fiber and smooth down the cuticle. However, plant-derived oils are commonly preferred by consumers due to anecdotal and emotive associations. Hence, the capacity of some oils to be absorbed by the cuticle and their effect on reducing hair swelling and maintaining cuticle integrity have been tested too. In this study, the response of African hair [curl type VI, according to Loussouarn *et al*. (2007)] to protective pre-treatments, in combination with moderate grooming cycles, was tested.

Materials and Methods

Figure 1: Image of hair tresses in ATLAS weathering cabinet

Materials: Four protective pre-treatments were applied (Table 1) on African hair tresses (2g each), not exposed previously to chemical damage (sourced by UAL).
Methods: Protective pre-treatment: 1 ml of pre-treatment per 1g hair, was massaged with gloved fingers on a tress and rested for 10 mins; the silicones were applied as 3% dilutions in Cyclomethicone whilst plant oils were applied neat; Grooming cycle**:** wash thoroughly with 3ml SLES, blow-dry for 2 mins, apply 55 combing strokes; repeat 3 times, followed by 25-30 seconds of thermal straightening at 215ºC. After three repetitions of the above protective + grooming cycle, a single 6h exposure of the tresses to solar radiation was conducted (Fig. 1)

Table 1: Active treatments

INCI name	Abbreviation
Crambe Anyssinica (Anyssinian) seed oil 50-65% (C22:1)	ASO
Orbignya Oleifera (Babacu) seed oil 40-50% (C12:0)	BSO
Bis-Aminopopyl Dimethicone	BAD
Silicone Quaternium-22	SQ22

Methods/hair fiber tests:
Tensile stress of wet fibre extended to 10.0% (24 fibers per treatment) (TA.XT Plus, Stable Micro Systems, UK) Digimatic Micrometer (Mitutoyo,UK); Hair colour (CM-2600D Spectrophotometer, Konica Minolta, Japan); Torsional Modulus: Dia-Stron FDAS770 and Dia-Stron FTT950 (28-30 fibres per treatment); Differential Scanning Calorimetry (Multicell Differential Scanning Calorimeter (TA Instruments, USA) and NanoAnalyze Data Analysis™ Software Version 1.2.0 (TA Instruments, USA)

Results and Discussion

Tensile properties at 10% wet tensile extension (Figure 2)
- The tensile stress data infers that pre-treatment with silicones increased the extensibility of wet hair

Torsional Properties for Virgin, Control, and ASO only (Table 2).
- The estimated dry elastic modulus (cortex related) infers that pre-treatment with ASO and grooming did not cause structural changes to African hair, although some cortex stiffening of unprotected hair was indicated
- The ASO reduced the G- modulus significantly, thus inferring softening effect on the cuticle

Denaturation temperature
- Challenges with the method's reproducibility, most likely due to remnants of the pre-treatments on the hair
- The data suggests that moderate grooming does not cause protein structural degradation in the cortex

Hair discolouration
- The most significant colour change occurred in the L and *b* values, with all hair increasing in yellowness
- The overall ΔE values suggest that ASO and SQ20 pre-treatment moderated the colour change

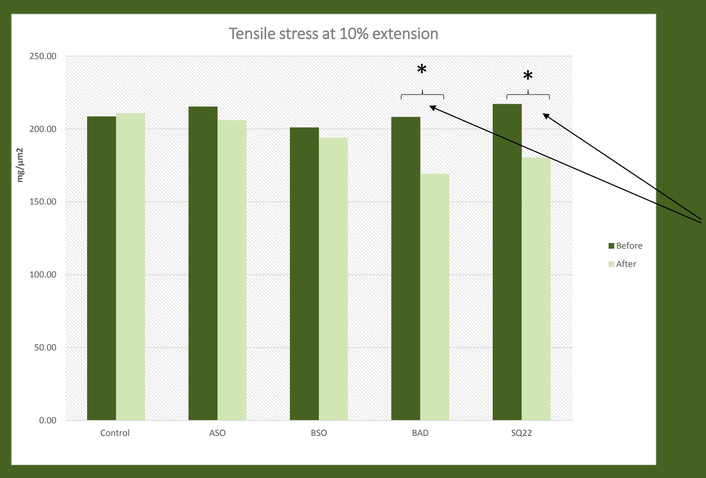

Figure 2: Tensile stress of African hair before and after different treatments

Before and after analysis: t-tests, *p<0.05

Between treatments analysis: One way ANOVA (Before treatments no statistical difference) After treatments: *p<0.05 between BAD & SQ22 vs oils and control

Table 2: Torsional modulus G and estimated elastic modulus E at 20% RH

	G (GPa)	E (GPa)
VIRGIN	1.68	4.04
CONTROL	1.67 *	4.43
ASO	1.52 *	4.13

Between treatment analysis: t-tests, *p<0.05

Table 3: Denaturation temperature

Treatment	Td°C
VIRGIN	141.6
CON	138.8
ASO	142.8
BSO	139.7
BAD	141.9
SQ22	141.7

Table4: ΔE values

Treatment	ΔE
VIR	-
CON	5.65
ASO	4.40
BSO	5.05
BAD	5.14
SQ22	4.10

Figure 3: Direction of colour change, comparison before and after treatments

Between treatment analysis: One-way ANOVA , *p<0.05 between all L and b values between BSO and BAD and the remaining treatments
Within treatments analysis: before and after t-tests *p<0.05

Conclusions

- The simulated three months of moderate grooming, combined with solar radiation exposure, caused cortex damage of minimal magnitude.
- Based on the conditions of these tests, the pre-treatments with silicones enhanced the hair manageability in the wet state and also reduced hair discolouration due to solar radiation; SQ22 was the more effective of the two actives that were compared.
- The pre-treatment with ASO, in particular, showed that the oils could improve the dry state of hair, by modifying the dry fibre's mechanical properties, which in turn aid manageability and styling techniques such as braiding and tie-up.
- The discoloration suggests that depending on the origin, African hair could suffer melanin degradation; however, all pre-treatments mitigated this effect, with ASO and SQ22 offering superior protection.
- In summary, the application of protection pre-treatment oils to African hair in the context of moderate grooming is likely to improve dry hair manageability and could reduce colour degradation thus maintaining cortex structural integrity in the long run.

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