A comparative investigation of the protective effects of natural oils vs. silicones on African and Caucasian hair types

ual: london college of fashion

Elizaveta Luneva, Gabriela Daniels

MSc Cosmetic Science, London College of Fashion, University of the Arts London, London, United Kingdom.

fashion business school

Introduction

Hair is constantly exposed to physical stress due to washing and combing, as well as heat styling, to achieve desired appearance set by trends and personal preferences. As a consequence of these activities, hair develops undesirable sensory attributes. On the cellular level, the cuticle becomes lifted, fractured and gradually completely degrades, leaving cortex cells exposed and weakened mechanically [1]. As a result, protecting the hair with cosmetic treatments is quite important for maintaining a healthy appearance.

The aim of this study was to determine the protective effects of two natural oils compared to two silicones on virgin Caucasian and African hair. For this, consumer behaviours in regarding to grooming habits had to be explored and materials with protective effects had to be determined. Protocols for testing were developed and performed and results were statistically analysed.

Materials and Methods

Hair was pre-washed prior to testing, before measurements were made and 1.0ml of active treatment (Table 1) per 1.0 g of hair was applied neat (if natural oil) or diluted to 3.0% in cyclomethicone (if silicone) and allowed to work for 10 minutes, which is thought to be the average time a hair treatment is left on. Each tress was then subjected to 'grooming cycles', which equated to 9 washing and drying sets, 495 combing stokes and 3 sets of hair straightening at 215°C. The tresses were then irradiated for a total of 6 hours (turned over half way) in a weathering cabinet with exposure of 300-800nm at 250W/m^2. This amount of exposure was thought to be equivalent to one month worth of damage.

Table 1: Active treatments

INCI name	Supplier	Abbreviation
Crambe Anyssinica (Anyssinian) seed oil	Clariant, Switzerland	ASO
Orbignya Oleifera (Babacu) seed oil	Beraca, Brazil	BSO
Bis-Aminopopyl Dimethicone	SilTech, Canada	BAD
Silicone Quaternium-22	Evonik, Germany	SQ22

Protective effects of treatments were assessed using the following tests: tensile stress of wet fibre extended to 10.0% (24 fibers per treatment) and wet tress combability- (both carried out on TA.XT Plus, Stable Micro Systems, UK), hair colour (CM-2600D spectrophotometer, Konica Minolta, Japan) and thermogravimetric analysis (Discovery TGA, TA Instruments, USA), where water loss of hair snippets heated in 10.0°C/min increments until 180.0°C, was assessed. The data gathered was statistically analysed using SPSS software.

Results and Discussion

Tensile properties

Tensile properties of the fibre reflect the integrity of the protein structures in the cortical cell. Within 10% extension such properties are determined by the disulfide bonds. The results infer that repetitive heat and wash, combined with UV radiation cause brakeage of disulfide bonds to hair that has not been subjected to prior oxidative treatments.

Caucasian hair (Figure 1) BAD was most effective at preserving the tensile properties of groomed Caucasian hair close to that of untreated hair. According to studies this silicone has a substantive effect and is able withstand up to six washes [2], thus exerting a protective effect. All other treatments showed tensile stress reduction after grooming on par with that of the control.

African hair (Figure 2) The natural oils preserved the tensile properties of African hair in line with previously published data [3] whilst the silicones did not.

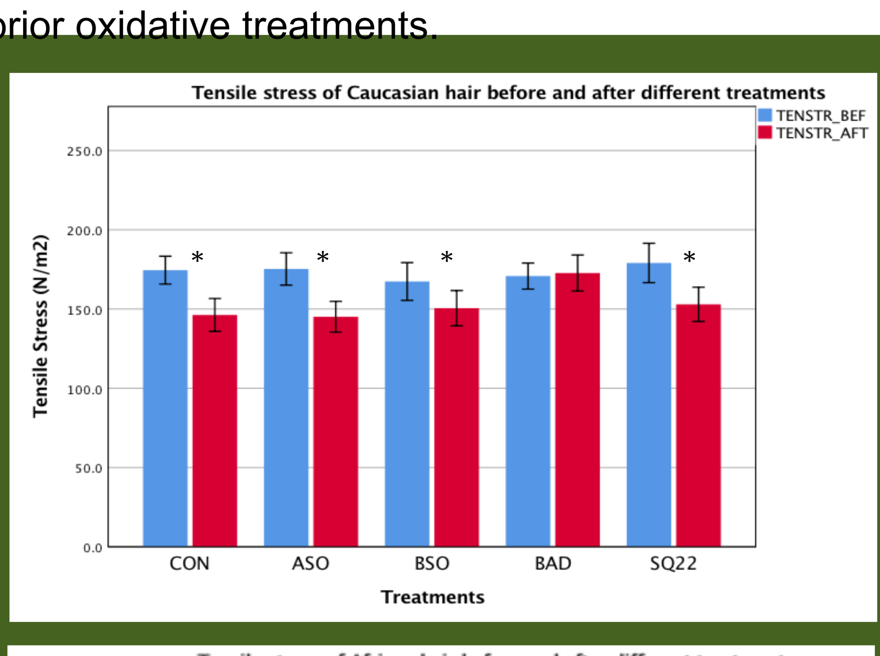

Figure 1: Tensile stress of Caucasian hair before and after different treatments

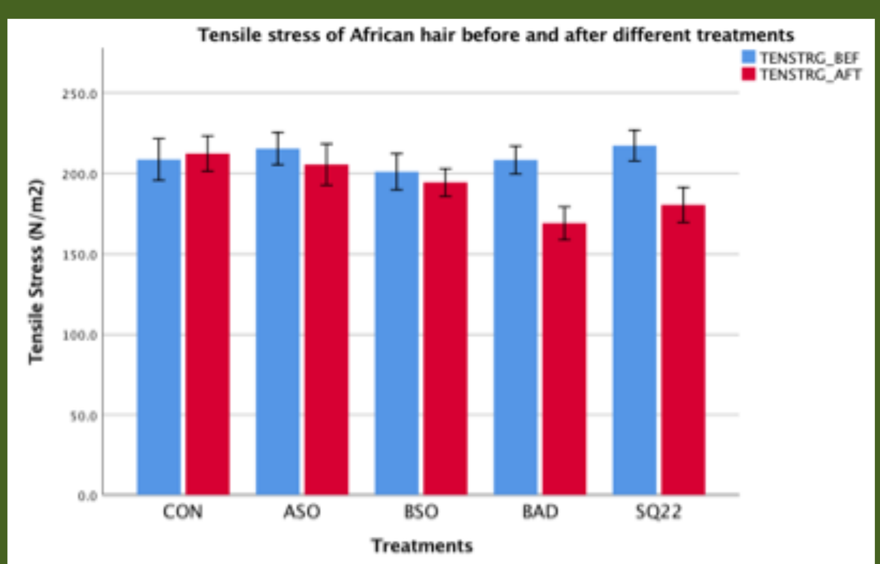

Figure 2: Tensile stress of African hair before and after different treatments

Combability

There was an expected increase in combability of control as hair was not protected. The results (Figure 3) show that Caucasian hair treated with natural oil ASO had a 6% reduction in combing force before and after. The oil was thought to form a film on the hair, allowing fibres to be held together through surface tension forces, reducing inter-fibre and comb-fibre friction [4].

However, oil BSO did not seem to have this effect and increased hair combability by 210%. This was assumed to be due to excessive shampooing which removes 20-90% free-lipids from the hair surface [5]. Silicone BAD increased combing force by 228% compared to control which was surprising as previous studies have shown that the material has heat protective properties [6].

SQ22 reduced combing forces by 11% which was assumed to be because of its high spreading coefficiency and good heat protective properties, which gave more likelihood of protection to each individual fibre. In addition, previous studies using differential scanning calorimetry have shown that SQ22 improves combability and reduces breakage of hair [7].

African hair combability was not assessed due to the high frequency of kinks in the fibres.

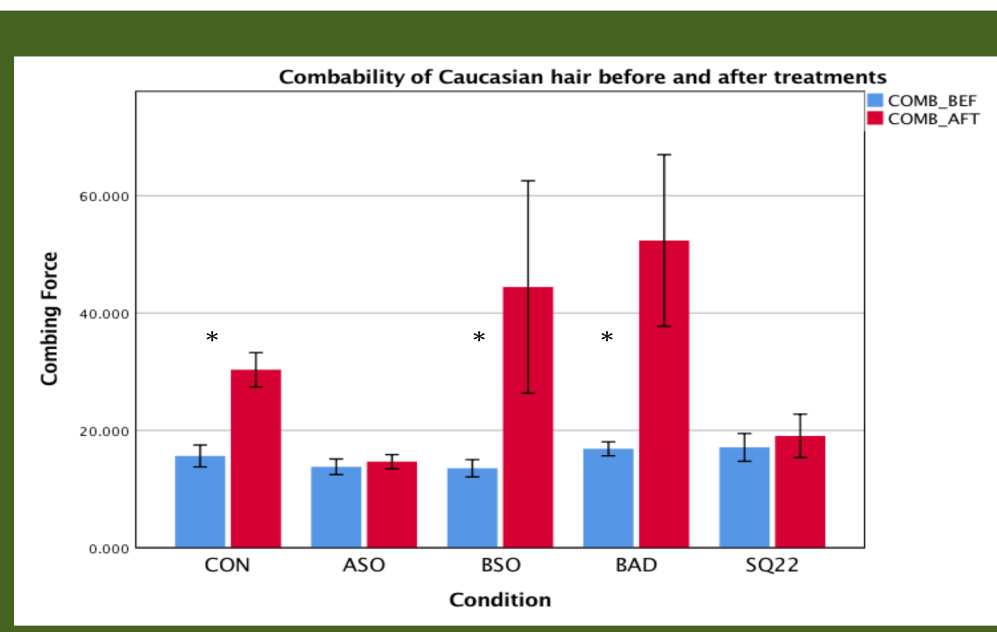

Figure 3: Combability of Caucasian hair before and after treatments.

Table 2: ΔE values for Caucasian and African hair after treatments

Treatment	ΔE value Caucasian hair	ΔE value African hair
CON	**0.98**	5.65
ASO	**0.40**	4.40
BSO	**0.39**	5.05
BAD	2.68	5.14
SQ22	1.45	4.10

There was no perceptible colour difference in Caucasian hair treated with natural oils (Table 2). Both silicones treatments showed colour difference through close observation in Caucasian hair, even though suppliers claimed heat protection and colour retention properties, however these were tested in vehicle formulations and assessments were made on light-brown hair only [8]. None of the active treatments appeared to protect the colour of African hair, which indicates that the hair became more damaged during grooming cycles. It is known that photo oxidisation of pheomelanin is more likely compared to eumelanin, thus the African hair may have had higher quantities of pheomelanin.

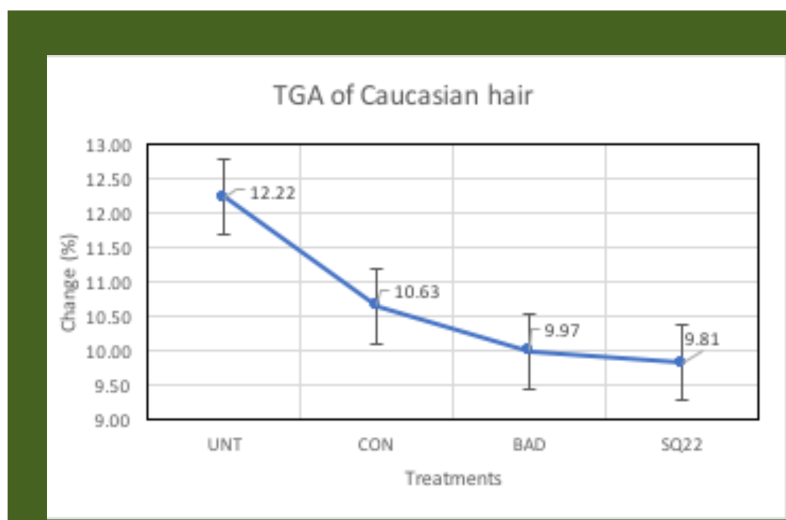

Figure 4: TGA Analysis of Caucasian hair with change (%) in water content.

Figure 5: TGA Analysis of African hair with change (%) in water content.

Water content in hair was assessed while temperature was increased from 40 to 180°C. Only selected materials, based on the combability and tensile testing data were tested for each hair type.

Both Caucasian and African hair samples treated with actives lost less water compared to untreated and control samples. Caucasian hair had a higher water regain compared to African hair, due to an initially higher water content which is expected as African hair is known to be dryer.

Silicones have low thermal conductivity, thus the presence of them along the hair shaft reduces denaturation of fibres when heated. In addition, their coating reduces water evaporation rate, thus materials BAD and SQ22 both reduced the % change in water compared to untreated samples (Figure 4).

In African hair (Figure 5), natural oil ASO was most effective at reducing water loss, previous studies using optical microscopy demonstrated that grooming produces gaps and cavities in the hair, which oils were able to impregnate and conceal, reducing moisture lost from fibres [9]. Natural oil BSO did not show a large difference in % change compared to control.

Conclusion

A difference in hair morphology between ethnicities means that grooming effects hair in different ways. Based on the results, it can be concluded that Caucasian and African hair responded differently to various treatments but In general, there was an indication that silicones perform better on Caucasian hair, while natural oils had a stronger effect on African hair. It was also noticed that certain materials were more effective at protecting particular parameters of the hair.

A combination of treatments may be required for optimised protection against all types of grooming damages, this outcome can be beneficial for chemists and new product development teams as it was concluded that specific treatments should be targeted towards damaged hair of different ethnicities.

The results were found to be quite varied, indicating that a more reproducible and repeatable process of treating and inflicting grooming damage is required. Similar studies in the field expose hair tresses to harsher conditions, so perhaps a higher amount of grooming cycles is required, as one month worth of grooming damage may not have been significant enough for noticeable benefits that the actives could offer. In addition, actives are usually added to vehicle formulations, thus the direct application may not have been an ideal way of assessing protective benefits, so perhaps, a more sophisticated method representing consumer behaviour is required.

References: [1] Garcia, M., Epps, J. and Yare, R. (1977) 'Normal cuticle-wear patterns in human hair', *Journal of the Society of Cosmetic Chemists,* 29, pp. 155-175. [2] Disapio, A. and Fridd, P. 'Silicones: use of substantive properties on skin and hair', *International Journal of Cosmetic Science,* 10, pp. 75-89. [3] Mendez, S., *et al.* (2011) 'Damaged hair retrieval with ceramide-rich liposomes', *Journal of Cosmetic Science*, 62, pp. 565-577. [4] Kamath and Weigmann (1986) 'Measurement of combing forces', *Journal of the Society of Cosmetic Chemists , 37, pp111-124.* [5] Shaw, D. (1979), 'Hair lipid and surfactants. Extraction of lipid by surfactants and lack of effect of shampooing on rate of re-fatting of hair', *International Journal of Cosmetic Science*, 1, pp. 317 - 328. [6] Marchioretto, S., Masse, *et al.* (2016) 'Heat protection getting warmer: speciality silicones for hair', *Cosmetics & Toiletries*, 131, pp. 40 – 51. [7] Evonik (2017) *ABIL T Quat 60.* Available at: https://glenncorp.com (Accessed: 19 November 2018). [8] Siltech (2019) *Silamine 2927.* Available at: https://www.siltech.com/industry-applications/personal-care/ (Accessed: 26 November 2019). [9] Gamez-Garcia, M. (2009) 'The effects of lipid penetration and removal from subsurface microcavities and cracks at the human cuticle sheath', *Journal of Cosmetic Science*, 60, pp. 85-95.