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THE FUTURE IS SCIENCE

Explorations of consumer relevant testing of textured hair

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INTRODUCTION

Textured hair is characterised by highly elliptical cross-sectional area and uneven overlap of cuticle cells [1]. These single-fibre characteristics affect how hair behaves when styled or treated, influencing manageability, style retention and cosmetic application. Lipophilic actives are frequently applied to textured hair as, in addition to their anecdotal performance, they deliver emotional benefits due to their association with haircare traditions. Up to date, vegetable oil penetration in the hair shaft has been investigated and reported with the aim of demonstrating fibre enforcement [2,3]. However, pure oil application to hair is impractical. Moreover, formulation vehicles may have significant role for the surface wetting and spreading, and for the penetration of any lipophilic active into the hair shaft. Furthermore, they will contribute to the sensory and perceived efficacy of the leave-in products. Hence, tress testing in combination with formulation characterisation will generate consumer relevant data about the lipophilic active performance. Furthermore, consumer data clarifying the application and reapplication product conditions could increase test relevance.

MATERIALS & METHODS

Consumer study: participants (n=123), self identified as curl type 4 hair

Formulation characterisation: TA.XT Plus Texture Analyser (Stable Micro Systems, UK); Thermo SientificTM HAAKETM MarsTM iQ Air rheometer (Cole-Parmer, UK)

Hair tress treatment: Ten tresses per conidiation (Figure 1), 1g of product (Table 1) applied on 1g of hair, incremental application with gloved fingers, hair left to air dry thoroughly between re applications (x4).

Hair testing: fibra.one (Dia-Stron Ltd, UK); TA.XT Plus Texture Analyser / Hair Stiffness Rig (Stable Micro Systems, UK). Sign test: comparing the direction of the median paired differences between conditions and time points.

Table 1. Hair treatments- formulation variables

Phase	INCI	Trade Name, Supplier	Contr. (w/w%)	Act. (w/w%)
A	Cetearyl Alcohol	Surfac CS (Surfachem, UK)	5	5
	Ceteareth-20	Eumulgin® B2 (BASF, UK)	2	2
	Triolein	AlgaPūr™ (Lubrizol, USA)	0	5
B	Aqua	Deionised water	89.5	84.5
	Glycerin	Glycerin (Phoenix, UK)	3	3
C	Preservative	Azelis, UK	0.5	0.5

Figure 1. Hair tresses for testing

RESULTS

Formulation characterisation: rheological and texture analysis results

- Both formulations were shear-thinning and solid-like. The Active maintained higher viscosity at rest, yielding more easily under stress and exhibited lower structural recovery.
- The Active formulation was firmer and more adhesive than the Control, indicating greater resistance to spreading and stronger product cohesion.

Table 2. Key results from rheological tests and texture analysis.

	Steady State Shear rate sweep	Oscillatory strain sweep		3ITT result	Spreadability test	
	Zero-shear viscosity (η_0) (Pa·s)	Critical strain (%)	G' & G'' Crossover strain (%)	Recovery %	Firmness (g)	Stickiness (g)
Control	9.0 ± 3.3	0.4 ± 0.2%	2.0 ± 0.9%	37.3 ± 2.8 %	121.4 ± 10.8	135.4 ± 11.4
Active	20.2 ± 8.7	0.4 ± 0.1%	1.0 ± 0.5%	28.8 ± 4.8 %	184.0 ± 13.8	220.0 ± 15.5

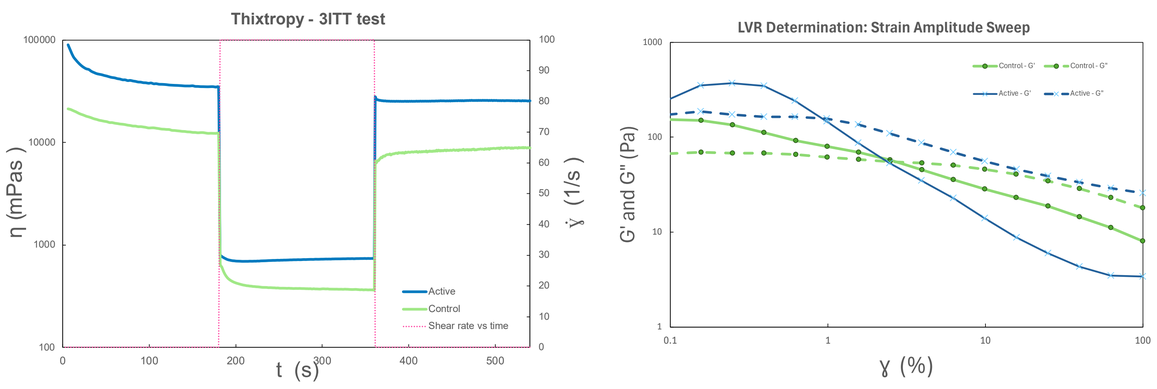
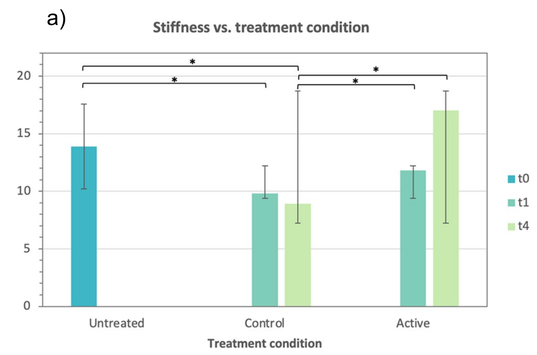
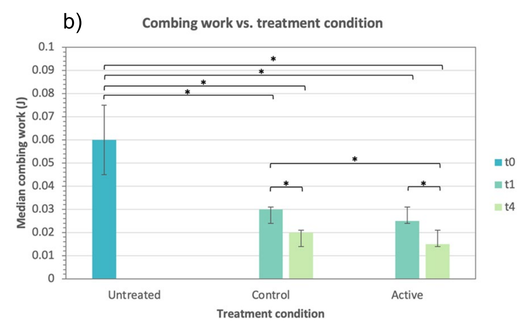


Figure 3. Typical rheology test results: oscillatory strain amplitude sweep, 3iTT(three-step flow method) test for thixotropy.

Consumer study and hair tress test results

- Consumer survey (n=123): mean age=39.1years, 78% self identified as Black.
- Hair goals positively associated with sectioning hair for product application.
- Hair wetting before product application/re application positively associated with using more products.





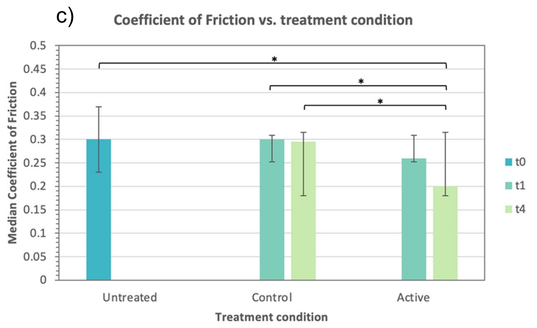


Figure 2. Results from hair testing, a) Stiffness, b) Combing, c) Friction.

<u>Hair tress testing</u>

- Single and cumulative product (Control and Active) applications caused a reduction in the work of combing. Multiple applications magnified the effect.
- Multiple Active formulation applications caused the hair to become stiffer, possibly due to the formulation's higher firmness.
- Multiple applications of Active formulation reduces friction; The lower critical strain allows easier spreading during use whilst its higher lipophilic content and higher viscosity/G′ show stronger structure and stability of the formed film on hair.

CONCLUSION

- **Three-prong approach to textured hair investigations: consumer goals and practices; formulation characterisation for performance and *in vitro* hair testing.**
- **Product texture (firmness and adhesion) relates to post application combined, hair and product, stiffness.**
- **Active product's critical strain and viscosity may be indicative of improved spreading and hair coverage, thus reducing hair friction and combing work**
- **Cumulative application of lipophilic actives from emulsion offers insights into how such product development should be approached**

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