IFSCC 2025 full paper (1527)

HALOGEN MOISTURE ANALYSER: A PRACTICAL APPROACH TO MEASURING HAIR TRESS DRYING TIME

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1. Introduction

Textured hair, encompassing curly and kinky types, is structurally distinct due to its elliptical follicle shape, leading to a helical fibre morphology that creates multiple bends and twists along the hair shaft [1,2]. These morphological features contribute to increased porosity, reduced sebum distribution, and heightened susceptibility to mechanical and thermal damage [3,4]. In addition, textured hair presents challenges in routine care, particularly in the drying phase, due to its tendency to retain water within the inner cortex and between the helical curves of the strands [1,3]. This results in prolonged drying times when compared to straight or wavy hair types, which can influence product performance evaluation and thermal styling outcomes.

Given the growing consumer demand for efficient, time-saving hair care routines – especially within the textured hair segment – there is an increasing need for standardized and objective methodologies capable of accurately characterizing hair drying behaviour.

To address this gap, a novel analytical protocol was developed using a thermogravimetric moisture analyser, which quantifies moisture loss in real time under controlled heating condition. This methodology mimics the thermal aspects of hair diffuser drying, a common practice among individuals with textured hair due to its gentle, non-disruptive action on curl patterns [5]. By providing precise, reproducible moisture loss curves, this approach enables the comparison of drying efficiencies across formulations and devices while minimizing the risk of thermal degradation.

This work presents the development, optimization, and application of this new analytical methodology, aiming to support the creation of hair care products and technologies that cater more effectively to the needs of textured hair consumers, ensuring both performance and protection.

2. Materials and Methods

A Moisture Analyzer Ohaus MB-45, typically used to quantify solid content, was employed to evaluate moisture loss in freshly washed hair tresses.

The Type IV hair tresses, classified by the L'Oréal scale [6] (Figure 1), were acquired from International Hair Importers & Products Inc. with 2 hair grams each.

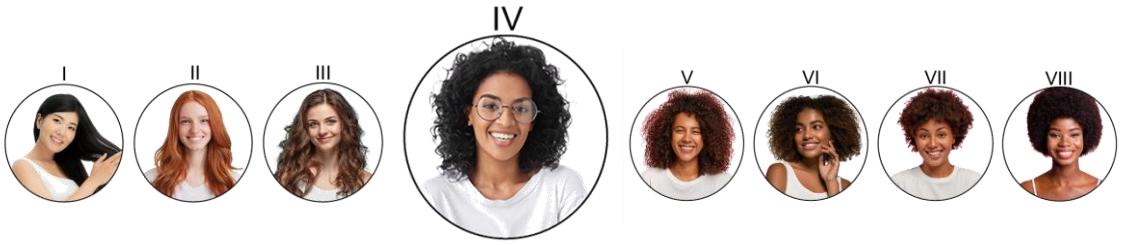

Figure 1. Hair types classified according to L'Oreal scale.

Hair tresses were pre-washed and standardized using a 10% Sodium Lauryl Ether Sulfate (SLES) aqueous solution to ensure consistent baseline conditions. Following this preparation, the tresses were divided into three groups and evaluated in triplicate, each receiving a distinct treatment protocol.

- **Group 1 (Control):** Tresses were saturated with distilled water only and served as untreated baseline control
- **Group 2 (Commercial Routine):** Tresses were subjected to a typical textured hair care regimen comprising a commercial shampoo, rinse-off conditioner, and leave-on conditioner, simulating common consumer usage
- **Group 3 (Pre-shampoo Treatment + Commercial Routine):** Tresses were first treated with an oil-based formulation applied as a pre-shampoo treatment, followed by the same commercial products employed in Group 2

Drying analysis was conducted using a thermogravimetric moisture analyser set to a constant temperature of 50 °C, a condition selected to simulate the thermal profile of a diffuser-type hair dryer. The test was programmed to automatically conclude when the sample's mass change was less than 1 mg over a 90-second interval, indicating drying equilibrium. Moisture content and total drying time were recorded directly from the instrument's software.

Figure 2. Moisture Analyzer Ohaus MB-45.

3. Results and Discussion

The objective of this study was to validate a novel analytical methodology capable of supporting future development of cosmetic products, with a specific focus on the needs of textured hair consumers and the reduction of hair drying time.

To this end, three treatment groups were evaluated: Group 1 (Control), which was wet with water only; Group 2, treated with a commercial routine (shampoo, rinse-off, and leave-in conditioner); and Group 3, in which an oily formulation was applied as a pre-shampoo treatment before the same commercial routine.

The reason for incorporating the oily pre-treatment was to create a partially hydrophobic barrier on the hair surface, aiming to reduce fibre swelling and limit water uptake during washing – thereby potentially accelerating the drying process.

Figure 3 presents the results for both drying time (represented by red bars) and water absorption (indicated by blue lines) across the three groups.

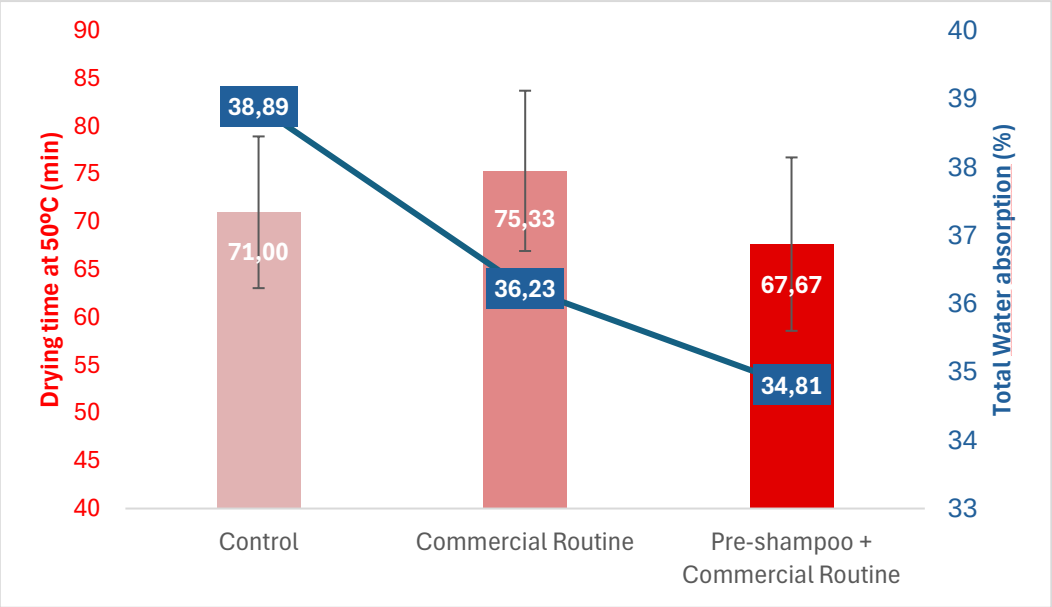

Figure 3. Drying time (red bars) and water absorption (blue lines) of each group of treatments.

As expected, Group 1 (control) exhibited the highest water absorption of 38.89% and the longest drying time, requiring approximately 71 minutes to reach complete dryness. This result reflects the unprotected state of the hair, which allows significant water swelling and retention due to its natural porosity.

Group 2, treated with the full commercial routine, showed a decrease in water absorption (36.2%), however this group presented an increase in drying time (75.3 min) when compared to the control. This is likely due to the presence of the leave-on conditioner, which may create a film-forming barrier that slows water evaporation.

In contrast, Group 3, which received the oily pre-treatment, demonstrated the lowest water absorption (34.8%) and a reduction in drying time by approximately 10% compared to Group 2. This result supports the hypothesis that applying an oil phase prior to washing can effectively reduce water uptake by acting as a physical barrier, leading to more efficient moisture loss during drying.

Despite the lack of statistically significant differences among the treatment groups at the 95% confidence level ($p > 0.05$), a consistent trend was observed across replicates. The data indicate that the oily pre-treatment (Group 3) led to the lowest moisture absorption and a shorter drying time compared to both the control and the commercial routine group. This trend aligns with the proposed mechanism of reduced water uptake due to the partially hydrophobic barrier formed by the pre-treatment.

The absence of statistical significance may be attributed to the inherent variability in hair fibre properties, the less weight of hair fibres and the relatively small sample size. Nevertheless, the methodology demonstrated sensitivity in detecting directional changes in both drying time and water absorption, supporting its applicability as a comparative analytical tool. In practical terms, even modest reductions in drying time are relevant for product performance claims, particularly within the textured hair care market, where long drying durations are a well-documented concern.

These results confirm the method's sensitivity in detecting subtle differences in drying behaviour as a function of treatment type. The protocol proved reproducible and capable of generating quantitative, interpretable results, making it a valuable tool for product development targeting performance claims such as faster drying or reduced water retention in textured hair.

Building upon the methodology validated in this study, future work may focus on the development and evaluation of new cosmetic formulations specifically designed to reduce hair drying time. By applying the thermogravimetric protocol, it is possible to screen and optimize ingredients or product strategies that promote enhanced drying efficiency without compromising hair integrity. Additionally, the method can be adapted to explore the impact of application modes, product layering, or mechanical drying tools. These investigations will contribute to creating more effective solutions for textured hair consumers, for whom drying time remains a critical aspect of daily hair care routines.

4. Conclusion

This study successfully validated a novel analytical methodology to assess drying performance in hair tresses, particularly addressing the needs of textured hair consumers. The use of a thermogravimetric moisture analyser enabled precise, real-time quantification of water loss under controlled thermal conditions, simulating diffuser drying.

Although no statistically significant differences were observed among the treatment groups, consistent trends demonstrated the method's ability to detect variations in drying behavior. Specifically, the oily pre-shampoo treatment showed potential in reducing both water absorption and drying time, highlighting its relevance in product development strategies aimed at improving drying efficiency.

The proposed methodology proved to be reproducible, sensitive, and applicable for comparative analysis of cosmetic treatments. As such, it represents a valuable tool for supporting performance claims related to drying time reduction, contributing to the development of innovative hair care solutions for textured hair.

5. References

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