COLOR FADING PREDICTABILITY: THE PROPOSITION OF AN ASSERTIVE IN VITRO PROTOCOL FOR HAIR COLOR EVALUATION

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Barros, Deborah[1]; Damas, Sandra[1]; Sato, Bruno[1]; Oliveira, Marina[1]; Santos, Fabiana[1]; Robert, Gael[2]; Farias, Juliana[1]; Mercurio, Daiane[1]; De Oliveira, Nathália[1]
[1] L'Oréal Research and Innovation, Rio de Janeiro, Brazil; [2] L'Oréal Research and Innovation, Saint-Ouen, France

1 INTRODUCTION

Hair colorants are widely used to cover gray hair or even to make it fashionable. Latin American countries, such as Brazil and Mexico, have a high penetration of hair color category. Moreover, the impact of UV rays on color behavior is a consumer concern due to the high exposure to UV radiation in these countries. The development of agile methods to assess color attributes *in vitro* is key to contribute in an innovative way to this category. In contrast, standard methodologies using spectroscopy to define color fading, without further investigation of each isolated parameter, proved to be too simplistic to reproduce the complexity of visual color perception, this way, in vitro hair color methodologies and analysis can be further improved. This study proposes a new way to assess and interpret fading of hair color treatments *in vitro*.

2 MATERIALS AND METHODS

HAIR SAMPLES

In this study, a complete process of fading, based on Brazilian consumers habits, was simulated for both shades 6.646 (representing the red family) and 7.0 (representing the blond family) on gray and bleached hair tresses. For each shade, two technologies were evaluated:

- Shade 6.646: Technology A and Technology B;
- Shade 7.0: Technology C and Technology D.

To simulate color fading, four weeks of the Brazilian weekly routine [2] comprising shampooing, conditioning, leave-on applying, grooming and heat tools associated with sun exposure was simulated in the hair tresses previously colored.

COLOR MEASUREMENTS

To assess color data, the tresses were analyzed by spectroscopy, using a spectrophotometer Konica Minolta CM-2600d [1], and categorized in terms of Color level and Reflects by Sensory Visual evaluation. The visual evaluation was conducted by an expert (trained operator) under standard lighting, GLE-M Series Multi-Source Luminaires model GLE-M5/ 32.

The results obtained were compared to those coming from a *in vivo* study (based on expert perception), panel of at least 4 volunteers per shade and at least 2 evaluators, in order to reach a method with high assertiveness.

The color measurements were done after coloring and after four weeks of Brazilian routine simulation.

3 RESULTS & DISCUSSION

The Cartesian coordinates of the CIELab space [3] are normally used to characterize the color. In this study, it was observed that the cylindrical coordinates of this system correlates better with the Sensory Visual Evaluation. Parameter L* presented a high correlation with Color Level and the parameters C* and h or the association of slightly variations on parameter L* with parameter C* and h correlate with Reflects. Results are shown in Figure 1 and Table 1.

According to the results, for shade 6.646, on both hair types, the technologies evaluated presented similar color level with some differences in the reflects intensity characterized by variations on luminosity (L*), saturation (C*) and hue (h) after coloring. The association of a higher value of parameter L* with a lower value of parameter C* for Technology A was perceived by visual evaluation in the reflects intensity. After 04 weeks of fading, Technology A presented a lower Total Color Variation (DE* %) indicating a lower color fading when compared to Technology B. However, by visual evaluation, Technology A presented more fading in reflects. The difference between the color fading results obtained by parameter DE* (%) and by visual evaluation can be explained by observing parameter L*, C* and h. Even though Technology A had presented a reddish hue when compared to Technology B, this technology presented a lighter and less saturated color. The association of parameters L*, C* and h results was perceived by visual evaluation as a dilution in reflects. The comparisons between the color fading results assessed by spectroscopy and by visual evaluation indicate the relevance of the evaluation of the final color of the hair tresses, Parameter L*, C* and h, in addition to DE* (%), in order to increase the method assertiveness.

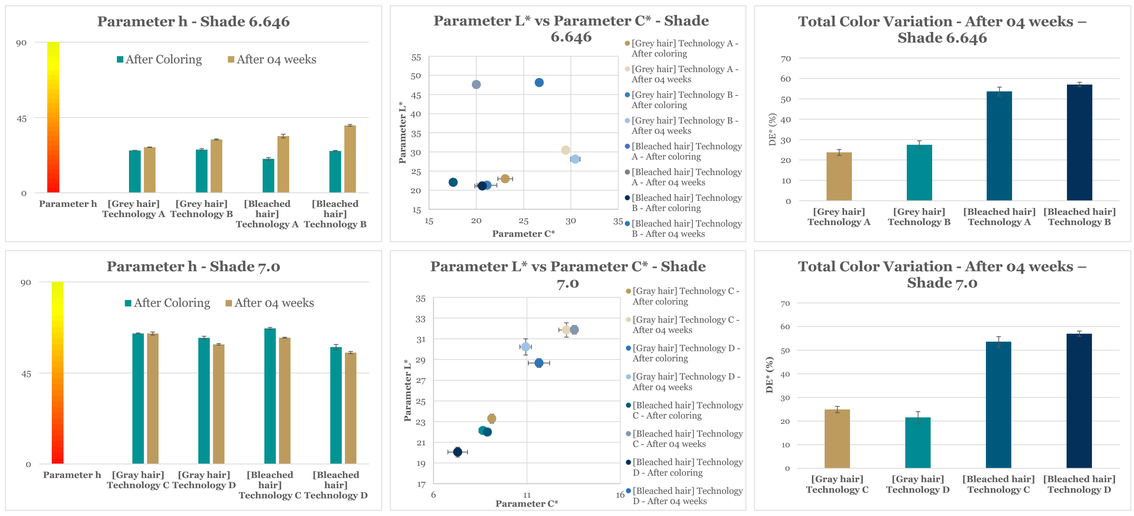

Figure 01. Average values of Parameters L, C, h and DE* (%) for each condition evaluated.*

Table 01. Summary of the comparisons based on Sensory Visual Evaluation.

EVALUATION MOMENT	PARAMETER EVALUATED	(a) *IN VITRO* COMPARISONS BETWEEN THE TECHNOLOGIES				(b) *IN VIVO* COMPARISONS BETWEEN THE TECHNOLOGIES	
		SHADE 6.646		SHADE 7.0		SHADE 6.646	SHADE 7.0
		GRAY HAIR	BLEACHED HAIR	GRAY HAIR	BLEACHED HAIR		
After coloring	Color level	Technology A presented slightly lighter color level (1/4) when compared to Technology B	Technology A presented similar color level when compared to Technology B	Technology C presented similar color level when compared to Technology D	Technology C presented a lighter color level when compared to Technology D	Technology A presented similar color level when compared to technology B.	Technology C presented similar color level when compared to technology D.
	Reflects	Technology A presented less mahogany reflects when compared to Technology B	Technology A presented slightly more violine reflects when compared to Technology B	Technology C presented colder reflects when compared to Technology D	Technology C presented colder reflects when compared to Technology D	Technology A presented slightly less red reflects when compared to technology B.	On grey hair, Technology C presented colder reflects then Technology D. On no grey hair, Technology C presented slightly more luminous reflects when compared to technology D.
After color fading	Color fading	Technology A presented more fading in reflects when compared to technology B. in general, after 04 weeks of fading, Technology A presented similar color level and less intense reflects than Technology B.	Both Technologies presented a higher level of fading. Technology A faded to more rose reflects while Technology b faded to more copper reflects.	Technology C presented similar to slightly more fading in color level, in reflects presented more change and different direction of color result when compared to technology D	The Technologies presented similar fading in color level. In reflects technology C presented more change and different direction of color results. When compared to Technology D.	The Technologies presented similar fading in color level (lower then 1/ 4 tone). In reflects, technology A presented more fading when compared to Technology B.	Similar color fading, Technology C presented reflects slightly more luminous.

For shade 7.0, on both hair types, it was possible to correlate Parameter L*, C* and h with the visual evaluation in terms of color level and reflects. It was observed some differences between the results achieved on the different hair types mainly for color level. After color fading simulation, the differences in reflects direction achieved by the technologies can be observed by the differences in Parameters L* and C*.

Moreover, for both shades, it was possible to correlate the *in vitro* results with those coming from the *in vivo* study, mainly on gray hair, indicating the method predictability. Brazilian hair fading routine and the colorimetric parameters proposed in this study are key tools to support the development of effective hair color technologies and suitable for consumer reality.

4 CONCLUSIONS

Based on the results, it was possible to correlate the cylindrical coordinates of the CIELab space with the expert visual evaluation. To assess color fading, the evaluation of Total Color Variation DE* (%) only proved to be too simplistic to reproduce the complexity of visual color perception. Moreover, the correlation between the data coming from the *in vitro* study with those from *in vivo* study indicates the method predictability. The *in vitro* methodology proved to be predictive with a high potential to simulate consumers real life.

References:

1. Mercurio, D. et al. Understanding Hair Color Durability: The effect of Brazilian habits in the colored hair fading. INTERNATIONAL FEDERATION OF SOCIETIES OF COSMETIC CHEMISTS CONGRESS, 2019, Milan. Proceedings.

2. Spectrophometer Konica Minolta CM-2600d: Instruction Manual. 2002-2014, Konica Minolta, INC.

3. Schanda, J. (2007). Colorimetry: Understanding the CIE System. Wiley.

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