

# Glypure™

## Glycolic Acid

## Color Fade Associated with Shampoo Formulations

### Product Information

#### Report Summary

Results show that changes in the color of permanently dyed hair do indeed arise as a result of washing—but, there is no statistically significant difference in overall color change as a result of using the shampoo samples (glycolic acid-based and non-glycolic acid-based) in comparison to a water-treated control. Although  $\Delta E$  values of around 3 are likely to be consumer perceivable, the magnitude of this change is still relatively slight. By means of illustration, differences twice this size are not uncommon when performing similar experiments on more damaged hair, while just ten passes with a heat straightening iron induce a larger change than seen here.

#### Summary of Experimental Details and Results

##### Objective

Evaluate the amount of color fade that occurs upon washing chemically dyed hair with three different shampoo formulations relative to a control treatment consisting of only water.

##### Samples

The following shampoo samples were provided by the requester:

- Control shampoo
- Shampoo with 6% glycolic acid
- Shampoo with 6% citric acid

#### Experimental

##### Hair

All testing was performed on natural blonde hair tresses procured from International Hair Importers & Products (Glendale, NY). The tresses weighed approximately 3 g, while measuring 1 in wide and 8 in long. The hair tresses were dyed in a highly reproducible manner using L'Oreal® Preference Dark Auburn (4R) permanent hair dye (see Appendix for our standard tress dyeing protocol).

##### Washing Protocol

Tresses were initially wetted by running under flowing water for 15 sec. All treatments were performed by applying a 15% sample dosage (i.e., 0.45 mL to a 3 g tress). The products were massaged through the hair for 1 min, followed by a 30 sec rinse with 40 °C (104 °F) water at a flow rate of 1 gpm. Between wash cycles, the hair was dried using a commercially available blow drier at the low-heat setting. Prior to measurement, the tresses were allowed to air-dry overnight and equilibrate at 60% RH.

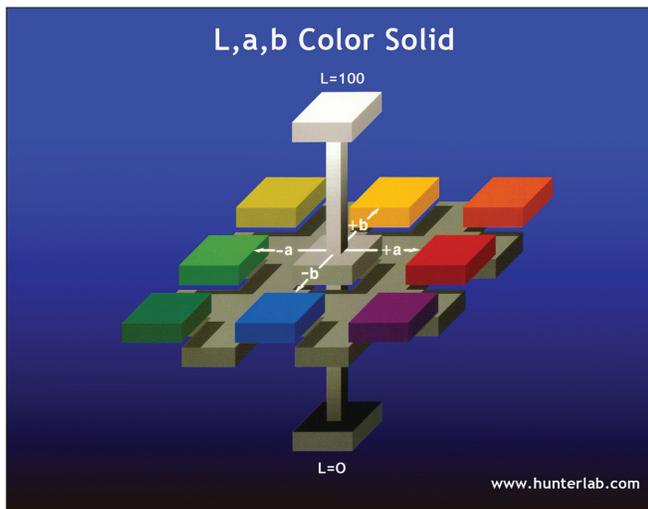
##### Methodology

Hair color was quantified with a Hunter Lab Ultra Scan XE Colorimeter in accordance with the CIELAB system. By this approach, color is measured in three dimensional space in terms of  $L^*$ ,  $a^*$ ,  $b^*$  coordinates (see **Figure 1**)—where  $L^*$  provides a measure of lightness on a scale of 0 to 100,  $a^*$  represents the red-green color range (positive value denotes higher red), and  $b^*$  represents the yellow-blue color range (positive value denotes higher yellow). As such, changes in color from the initial dyed state as a function of washing cycles can be represented in terms of  $\Delta L$ ,  $\Delta a$ , and  $\Delta b$ .

In addition, it is common to see an overall color change,  $\Delta E$ , being reported that is calculated using the equation given below.

$$\Delta E = \sqrt{(\Delta L^2 + \Delta a^2 + \Delta b^2)}$$

**Figure 1. L,a,b System for Color Evaluation**



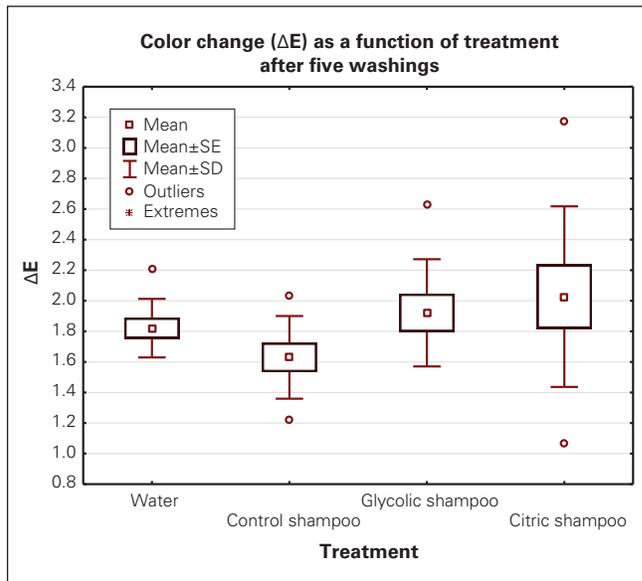
Each test cell involved eight replicate tresses to provide the appropriate statistical rigor. The color of each tress was obtained from the average of ten individual measurements over the length of the hair.

**Results**

In each case, data is represented using Box & Whisker plots that were generated using Statistica™ software. Statistical analysis in each case was performed using an ANOVA at the 95% confidence level.

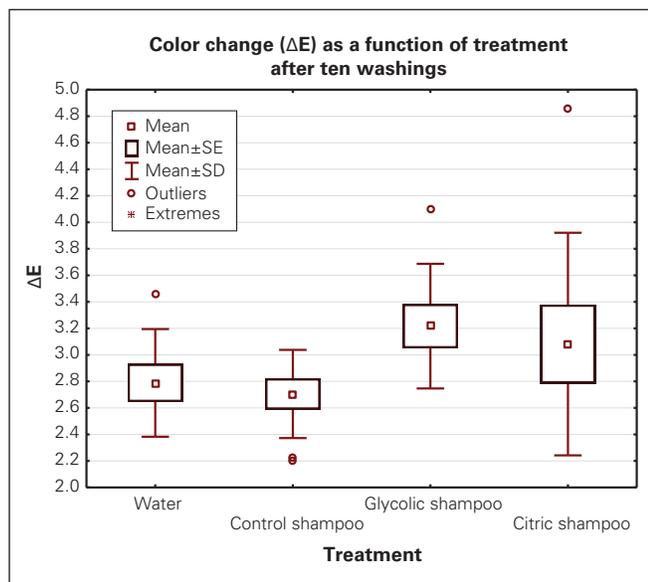
It is most common to see color fade results being reported in terms of an overall value, i.e.,  $\Delta E$ . Results after five and ten washings with the various shampoos are given in Figures 2 and 3.

**Figure 2.  $\Delta E$  After Five Washes With the Various Shampoo Formulations**



Treatment	N	Mean	Std Dev	Std Err Mean	
Citric shampoo	8	2.0	0.6	0.2	A
Glycolic shampoo	8	1.9	0.4	0.1	A B
Water	8	1.8	0.2	0.1	A B
Control shampoo	8	1.6	0.3	0.1	B

**Figure 3.  $\Delta E$  After Ten Washes With the Various Shampoo Formulations**



Treatment	N	Mean	Std Dev	Std Err Mean	
Glycolic shampoo	8	3.2	0.2	0.2	A
Citric shampoo	8	3.1	0.2	0.2	A
Water	8	2.8	0.2	0.2	A
Control shampoo	8	2.7	0.2	0.2	A

It is widely believed that a  $\Delta E$  value greater than 1 is perceived by most when comparing samples that sit next to each other, while a  $\Delta E$  of 2 or more is noticeable for samples not adjacently located. This second value is being reached after five washings and has been exceeded after ten washings. Therefore, results suggest perceivable levels of color fade are being induced. With this said, there is very little difference in overall color fade between any of the four treatments—which includes the water control. It is, therefore, evident that the shampoos themselves are not the source of this undesirable occurrence and that water appears to be the culprit. In short, the above results show no statistically significant differences between the overall color fade from the control water treatment and the three shampoo formulas.

Nonetheless, it is noted that the magnitude of this color fade is not especially dramatic. Specifically, considerably higher values are obtained as the hair quality declines and diffusion both into and out of the hair increases. To further put these results in context, ten passes with a commercial straightening iron at the highest temperature setting produced a  $\Delta E$  of 4–5.

### Summary/Conclusions

Results show that changes in the color of permanently dyed hair do indeed arise as a result of washing—but there is no statistically significant difference in overall color change as a result of using the shampoo samples in comparison to a water-treated control. Although  $\Delta E$  values of around 3 are likely to be consumer perceivable, the magnitude of this change is still relatively slight. By means of illustration, differences twice this size are not uncommon when performing similar experiments on more damaged hair, while just ten passes with a heat straightening iron induce a larger change than seen here.

### Appendix

#### Standard Tress Dyeing Protocol

The hair was dyed in blocks of 16 tresses per box of dye. The dye was applied to each tress at a dosage of 1 mL per tress (divided into 0.5 mL per side). The dye was left on the hair for 40 min with periodic massaging of each tress to ensure even coloring. The tresses were then rinsed under an intellifaucet set at 40 °C (104 °F) with a controlled flow rate of 1 gpm for 1 min (i.e., until the water ran clear).

#### Commercial Dyeing Kit Used for Tress Preparation

L'Oreal® Preference Dark Auburn (4R)

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