Effect of semi-permanent hair dyes and conditioning polymers on the colour enhancing properties of shampoo formulations

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Introduction

The **colour fading of permanently dyed hair** is attributed to the daily shampooing process, the overall quality of the hair and the environmental impact, e.g. UV light exposure. The addition of ionic and non-ionic polymers and silicones to hair shampoos has been found to improve the colour fastness of permanently dyed hair [1,2,3]. To enhance this effect and to go beyond it, the addition of some colourants to the shampoo could be considered. Direct dyes are the obvious choice due to their capacity to impart colour when applied directly to the hair and not requiring long exposure times.

The addition of polycationic cellulose-based polymers to the dye bath had been found to improve the dye uptake and retention after up to nine wash cycles [4]. Therefore, **a wash product with a mild colour-enhancing effect could be developed by combining the effects of temporary dyes and polymers**. This paper investigates the colour retaining efficacy of shampoo compositions, containing polymers and semi-permanent hair dyes, on hair tresses pre-coloured with permanent red oxidative dye.

Materials and Methods

Virgin Caucasian brown hair tresses (weight 5.5 g ± 0.1 g, length 15 cm) were first bleached and then dyed, using a commercial hair bleach kit and a level-3 commercial oxidative red hair dye. This pre-treatment was selected as, due to the bleaching effect on the cuticle and cortex, the hair colourant was anticipated to be more prone to shampoo-induced fading.

Formulations:

Each shampoo treatment contained a shampoo base comprising Disodium Sulfosuccinate (10%), Cocoamidopropyl Betaine (3%), a preservative and the respective active(s) at concentrations recommended by the suppliers (Table 1). The pH of all formulations was adjusted to 6, using a Sodium Hydroxide solution.

Investigated actives:

- Conditioning polymers - **Polyquarternium 10 (PQ-10)** and **Hydrolyzed Wheat Protein PG-Propyl Silanetriol (HWP).**
- Cationic dyes - **Basic Red 51** and **Basic Red 76** (Fig. 1 and Fig. 2). Each of the dyes was incorporated alone and in all respective polymer/dye combinations (Table 1).

Table 1. Shampoo treatment formulations

Shampoo base (w/w)	Dye 51	Dye 76	PQ-10	HWP
13%	-	-	-	-
13%	0.0005%	-	-	-
13%	-	0.05%	-	-
13%	0.0005%	-	2.0%	-
13%	-	0.05%	2.0%	-
13%	0.0005%	-	-	5.0%
13%	-	0.05%	-	5.0%

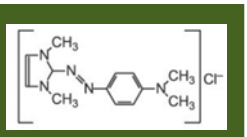


Figure 1. Basic dye 51

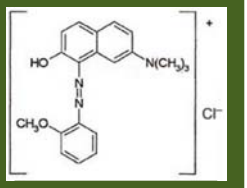
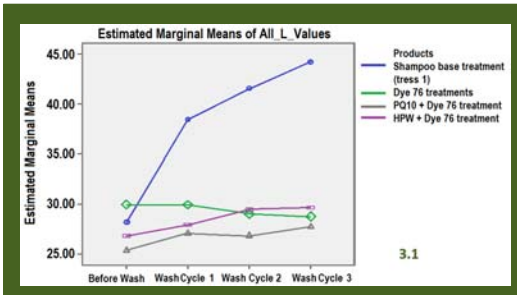


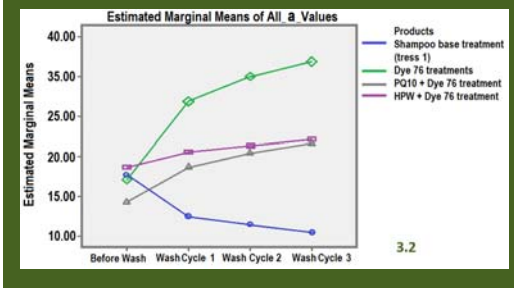
Figure 2. Basic dye 76

Test treatments and data analysis:

- Each shampoo treatment was applied to the pre-dyed hair tresses three times, following a defined wash-and-dry treatment protocol.
- Colour measurements of the dry hair tresses were taken (Spectrophotometer CM-2600D, Konica Minolta, Japan) before the washing (control) and at the end of each treatment (also referred to as wash cycles 1, 2 and 3).
- Three measurements per hair tress were taken at identical distances along each tress. The selected measuring conditions for the instrument were: illuminator D65 (daylight), viewing angle 10°, specular light included (SCI).
- The spectrophotometer measures colour using the CIE Lab colour space. For the purpose of this study, the ***L*-values** (signifying the lightness/darkness) and ***a* values** (signifying the position of the colour in the red-green axis) were analysed.
- The data was first reviewed for normality, followed by a two-way ANOVA and Tukey Honest Significant Difference (HSD) tests, applied to the set of data generated for each dye respectively. The statistical programme SPSS (IBM, USA) was used for this analysis. Probability results >95% have been reported (p<0.05).

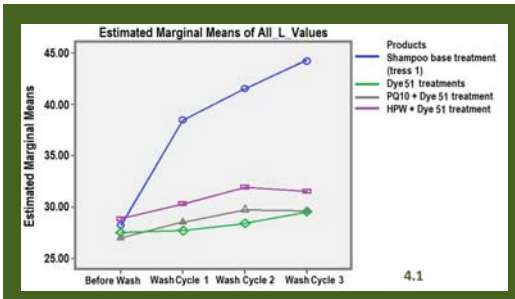
Results and Discussion

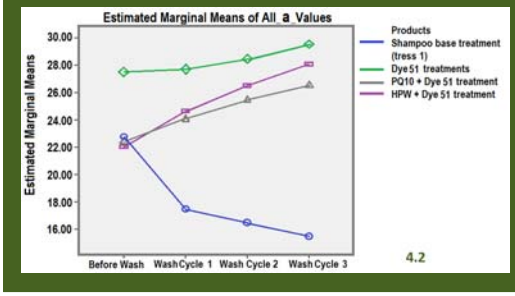




D76 in combination with PQ-10 maintained the lightness and vividness, thus implying that any surfactant-induced colour loss was counteracted by the deposition of the cationic dye. D76 in combination with HWP maintained lightness, but progressively increased vividness ($p < 0.05$ between all cycles) implying accumulation of the direct dye between cycles (Fig. 3).

Figure 3. Dye 76 mean values for:
1) L - lightness;
2) a - the colour position on the green-red axis.





Dye 51 in combination with each polymer caused a very moderate increase in lightness, accompanied with an increase in vividness ($p < 0.05$ for *before wash* L and a values and *cycle 3*) suggesting moderate and cumulative dye deposition (Fig. 4).

Figure 4. Dye 51 mean values for:
1) L - lightness;
2) a - the colour position on the green-red axis.

Conclusion

This study demonstrated that **colour fading management can be successfully delivered by wash products**, despite the short contact time between the semi-permanent dyes and the hair.

The effect of such products was attributed to:

- the presence of polymers which reduce the leaking of the permanent dye chromophores and aid the distribution and retention of semi-permanent dyes;
- the mild enhancement of colour vividness due to the use of small quantities of direct cationic dyes.

The conditioning effect of such products will also have a positive impact on other hair surface attributes such as shine, which enhance the human perception of colour.

References:
[1] Zhou, Y., Foltris, L., Moore, D.J. and Rigoletto, R. (2009) Protection of oxidative hair colour fading from shampoo washing by hydrophobically modified cationic polymer. *Journal of Cosmetic Science*, 60, pp.217-238; [2] Daniels, G., Katakami, K., Grant-Ross, P., and Tamburic, S. (2014) An *ex vivo* study of the effects of co-surfactants and conditioning additives on hair colour protection, *22nd IFSCC Congress*, Paris, France; [3] Marchioretto, S. (2004). The use of silicones as a colour lock aid in rinse-off hair conditioners. *Journal of Cosmetic Science*. 55, pp.130-131; [4] Ballerin, B., Galli, S. and Morigi, M. (2008) Influence of cellulose polymers on the semi-permanent dyestuff process of yak hair: An analytical investigation. *Journal of Cosmetic Science*, 59, pp.105-115.