

EFFECT OF SEMI-PERMANENT HAIR COLOR CONDITIONER FOR MAINTENANCE HAIR COLORING

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Abstract

Hair color fading is a common problem in artificial hair colorants complained by both young and elderly consumers. One of the main reasons is the open of hair cuticles that allows color escaping out upon shampooing. To overcome color fading problem, the semi-permanent hair color conditioner was developed. The effect of semi-permanent hair color conditioner for maintenance of hair coloring were studied in this work. The experiment was carried out on red brown permanent dyed hair tresses with and without treatment of semi-permanent hair color conditioner. After shampooing for 50 times, the comparative efficiency of color maintenance between untreated and conditioner-treated groups was performed using colorimeter based on CIE L*, a*, b* color scale. The result showed that percent changes of a*- value and ΔE of conditioner-treated group were significantly lower than that of untreated group ($p < 0.05$). This indicated that semi-permanent hair color conditioner appears to be an effective product for the maintenance of hair coloring.

Keywords : hair color fading; hair color maintenance; conditioner; hair dye; hair care

Introduction :

Color fading is a common problem in everyone who dyed their hair has a tendency to be found after doing artificial hair colorant (Morel and Christie 2011). The almost causes of off-shade fading may be simple to suffer in daily life unavoidably. There are two majority of possible causes that may influence color fading in hair dye, first is the physical factor that can be mostly attributed to wash-out during the shampooing process. In cleansing or washing mechanism of shampoo relies on the use of surfactants form micelles that are able to solubilize hydrophobic substance from hair strand include hand-washing, water rinsing, surfactant solution (Daniels et al. 2015), combing, drying process with high temperature in routine of hair care (Scanavez et al. 2003), hair styling increase violence of damaged hair that have more degree of furtherance fading in dyed hair (Zhou et al. 2009). Second is a chemical factor, sunlight exposure that ultraviolet type A (UVA) and ultraviolet type B (UVA) radiations are liable for color lightness change (Nogueira and Joekes 2004) by break down the chemical bond of structure on hair and hair dyed molecule and the truth is both of factors efficiently work together to fade and change the shade in dyed hair (Locke and Jachowicz 2005).

The duration and period of hair dyed that remain on hair strand also depend on types of hair dye that used in hair colorant application. Types of hair dye and their mechanisms play important role to indicate the duration of hair color fastness and resistance of color fading on hair strand (França et al.

2015). There are two courses of action to classify hair coloring product based on adhering duration or affinity on the hair and their mechanism. The important different is the coloring product's affinity for the hair. Affinity describes how tightly the color molecule bonds to the hair. Greater affinity means longer-lasting color (Halal 2009). Temporary, semi-permanent, demi-permanent and permanent color are the first course of action to classified follow by resistance durability after the application on hair. Second is based on their mechanism, the mechanism of hair colorant can divide to two main categories, oxidative and non-oxidative colorations (França et al. 2015). These mechanisms are different in dye molecule type, component in formula and method of dye molecule to penetrate and strain on hair. The penetration ability of color molecule and hair layer where dye stained also has effect of affinity, said that more ability and deep of penetration means more achieving in long-lasting effect (Halal 2009).

There are three layer of hair strand; Cuticle, Cortex and medulla. Cuticle is the most outer layer follow by cortex and medulla. The layers which relate with artificial hair coloration are cuticle and cortex that are the location of hair pigment and hair dye (Dawber 1996). The formula of non-oxidative hair dye contains colorful molecule or dyes deposition. This type of hair dye has high molecular weight and large molecule size that almost dye molecules deposit on cuticle layer with less ability to penetration (Bolduc and Shapiro 2001). In permanent hair dye that is the oxidative coloration, the dye molecule in oxidative coloration calls precursors or oxidation hair dyes that primary is colorless and will become color when oxidize with oxidation agent (Tucker 1967). In permanent hair dye contains alkaline agent that help to open hair's cuticle and enhance more efficiency to deeply penetrate of dye molecule and enlarge size when react with coupler in hair cortex that may difficultly penetrate out of cuticle and cortex.

However, the hair that has high porosity can take color quickly and in the same way, color also tends to fade quickly (Gerson et al. 2013). For long lasting effect, hair dye could be deeply penetrated to cortex layer but in the same way, the method that bring the dyed in to deeper layer normally loss of barrier function that is the cause of losing healthy hair structure means hair damaged (Harrison and Sinclair 2004).

Cuticle is the most outer layer that acts like the barrier of hair strand and plays important role to maintain dye molecule on hair, swelling on hair cuticle is caused from chemical application on hair such as bleaching and permanent waving that lead to hair damaged and allow water in and out of hair easily. That related to the condition of water solubility in hair dye molecule, the synthetic dyes used in hair colorant are water soluble and almost water is more alkaline than hair that swells the hair and strips hair dyes molecule out of the hair shaft (Halal 2009) and lead to color escaping. Healthy cuticle may be able to protect fading of hair dyed and cuticle treatment is the one choice to maintain hair color (Dawber 1996).

From global hair care trend of 2015 directs increasing numbers of consumers have more interesting in alternative cleansing condition in multi-function in hair care product and fast growing of brightening and illumination product in few years ago that the expectation of further hair care trend shows growing of cleansing with conditioner and more claims based on adding shine and light with products featuring light boosting are coming trend (Morel and Christie 2011).

The propose of this study was focus on the efficiency of conditioner containing hair colorants for synergistic function that may help to maintain artificial hair color and decrease off-shade hair color or dull color and fading in dyed hair.

Methodology

Materials

Semi-permanent dye hair color was obtained from Teluca Incorporate, USA which is distributed by GeTeCe Co., Ltd., Thailand. Cetyl alcohol was obtained from Godrej industries Ltd., India. Polyquaternium-81 was obtained from Aqua-Medl products Pte., Ltd., Singapore. Glyceryl Stearate (and) PEG-100 stearate was obtained from Inolex Chemical Company, USA. DMDM hydantoin was obtained from Sharon Laboratories Ltd., Israel. PEG-12 dimethicone was obtained from Xiameter dow corning Ltd., Thailand.

Hair samples

Virgin hair was collected from volunteer and divides to 11 tresses. Each hair tress is 1.5 wide and 10 cm in length of loose hair. In this experiment, practiced hair samples are same head from one volunteer. Hair sample was divided into two groups, 5 tresses for untreated group, 5 tresses for color-treated group and the last one is control.

Hair dye and preparation of dyed hair tresses Bleached hair

All hair samples were bleached with commercial bleached hair product, used developer 12% 40 vol. and powder bleach mixed together. Hair samples were bleached 2 times for 40 minutes at room temperature. Bleaching hair are applied on hair sample for degrade natural pigment to prepare for lighter shade dying (Bolduc and Shapiro 2001). That eumelanin is more easily oxidized than pheomelanin based on oxidation reaction (Wolfram et al. 1970).

Permanent hair dye

All hair samples were dyed with commercial permanent hair dyes product for red brown color because red or auburn hair dyes have been shown to fade more than other shades based on their molecule easily to soluble with water and red paint can often degrade faster because it absorbs higher energy and shorter wavelength light. Its ingredient labels are as follows: aqua/water, stearyl alcohol, oleic acid, cetyl alcohol, ammonium hydroxide, propylene glycol, cetareth-20, 2-chloro-p-phenylenediamine sulfate, p-aminophenol, 4-amino-2-hydroxytoluene, sodium sulfite, ascorbic acid, fragrance, Tetrasodium EDTA, phenyl methyl pyrazolone, 4-amino-m-cresol. All hair samples were dyed for 40 minutes. After dying, hair tresses were rinsed under running tap water for 1 minute which was enough to remove the surface residual dye from the hair. The dyed hair tresses were dried with no-heat wind from blow dryer for 1 minute before they were used for experiment.

Conditioner formulation

The conditioner color protection composition of the formulations shown in Table 1.

Table 1 Conditioner formulations

Part	Ingredients	Weight % (w/w)		Function
		F1	F2	
A	Aqua/water	q.s.	q.s.	Diluent
	<u>Tetrasodium</u> EDTA	0.2	0.2	Chelating agent
	<u>Hydroxyethyl</u> Cellulose	1.5	1.5	Thickener
B	<u>Glyceryl</u> Stearate (and) PEG-100 stearate	1.0	1.0	Emulsifier
	<u>Cetearyl</u> Alcohol	1.0	1.0	Emulsifier
C	Polyquaternium-81	0.3	0.3	Conditioner
D	PEG-12 <u>dimethicone</u>	9.1	9.1	Conditioner
E	DMDM <u>hydantoin</u>	0.4	0.4	Preservative
	Semi-permanent hair color	-	3.0	Color
	Total	100	100	

Semi-permanent hair color composition of the formulations shown in Table 2.

Table 2 Semi-permanent hair color composition.

Part	Ingredients	Function
A	Aqua	Diluent
	Isopropyl alcohol	Solvent
	<u>Propanediol</u>	Humectant
	<u>Ethoxydiglycol</u>	Humectant
	<u>Aminomethyl</u> propanol	Buffering agent
	<u>Tetrasodium</u> EDTA	Chelating agent
B	Acid Violet 43	Temporary color
	HC Yellow No. 2	<u>Semipermanent</u>
	HC Red No. 3	<u>Semipermanent</u>
	4-hydroxypropylamino-3-nitrophenol	<u>Semipermanent</u>
	N,N'-bis-(2-hydroxyethyl)-2-nitro-phenylenediamine	<u>Semipermanent</u>
	HC Blue No. 2	<u>Semipermanent</u>

Washing procedures of dyed hair

Hair sample was divided two groups; color-treated and untreated groups control is the hair tress were dyed without any washing process using for color indicator. Untreated group is the group of hair samples were washed with commercial shampoo which contained SLS and SLES that was used in shampooing in washing procedure with gentle rub for 1 minute and then rinse off with running tap water follow by basic conditioner in formula 1 with gentle rubs for 5 minute and rinse off with running tap water and finally, brow dryer without heat was used for dried the hair swatch. Repeat as before sets and record to color fading and color-treated group were performed by the same instructions but different in conditioner which was used formula 2 that was developed conditioner.

In each washing procedure was comprised with shampoo, conditioner treatment and dried process that was created emulations the hair washing routine, 50 times of washing was designed for mimic the average number of washing in 3 months that was the suitable time for re-colorant. The samples in each group were divided during procedure when 10th wash, 20th wash, 30th wash,

40th wash and 50th wash completed. Color in hair samples were measured at 10th wash, 20th wash, 30th wash, 40th wash and 50th wash as divided sample.

Measurement and Analysis

For color measurement, CIE L*, a*, b* color scale are used in this experiment that are collected from Chroma meter CR400 (Konica Minolta CR400) and analyze bases on opponent process theory of color perception. L*-value, a*-value and b*-value are measured and translated in numeric scale from Chroma meter.

L*-value indicated the lightness of color by scale 0-100 are used, 0 referred to darkness or black shade and 100 are referred to brightness or white shade in substance.

a*-value indicated to red-green pair, positive value was referred to red hue and negative value was referred to green hue.

b*-value was indicated yellow-blue pair, value on positive-axis was referred to yellow hue and value on negative-axis was referred to blue hue.

$$\Delta E = \sqrt{((\Delta L^*)^2 + (\Delta a^*)^2 + (\Delta b^*)^2)} \tag{Equation 1}$$

where ΔL^* = brightness, Δa^* = red-green proportion, Δb^* = yellow-blue proportion

Results :

Total color different in control and sample

Total color different (ΔE) is the value that shows color changing between control and sample which is calculated by Equation 1. Higher value of ΔE shows more different that can demonstrate that the last color of sample have a lot of change from control. And lower value of ΔE will show less color changed of sample when compared with control. For the aim of this experiment is a hair dye maintenance by applying conditioner formula plus hair color pigment. Therefore the ideal value of total color different should be equal to zero that means no change in last color when compared with control or the first color after hair dyed in each wash and no change in every washing since the first time washing until the last time. There are two group of sample, color-treated group and untreated group.

From Figure 1 shows total color different (ΔE) between color-treated sample and untreated sample. The result of untreated sample shows higher total color different and trend to rise up each 10 times of washing, the different of ΔE in 10th and 50th wash in untreated sample is 3.28 , ΔE at 10th wash and 50th wash samples are 7.41 and 4.13, respectively. The result of color-treated samples shows lower total color different when compare with untreated sample. The different of ΔE in 10th and 50th wash in color-treated sample is 1.38; ΔE at 10th wash and 50th wash samples are 3.33 and 4.71, respectively. From this result can demonstrate that in untreated group has more total color different than color-treated group. And the first sample at 10th wash and the last at 50th wash of color-treated sample have lowered different during 10 to 50 wash when compare with untreated sample. Color-treated group have stability of color rather than in untreated group. The smaller of ΔE is requiring for color maintenance However, color-treated group also change from control.

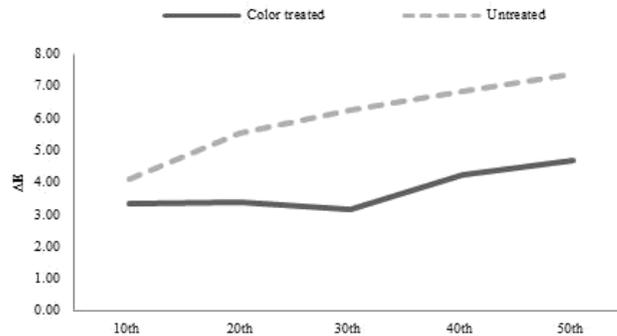


Figure 1 Total Color Different (ΔE) between control and sample.

Red color change

CIE L^* , a^* , b^* color scale are used in this experiment bases on opponent process theory of color perception (Hunter associates laboratory, Inc. 1996) by 3-dimension rectangular color space scale can describe in numeric scale to determine color on L^* -value, a^* -value and b^* value. In L^* scale determines light and dark in color (0-100), nearest to 100 can refer to light shade and nearest to 0 can refer to dark shade combine with a^* scale determine red and green pair, positive value refer to red shade and negative value refer to green shade and b^* - scale determine yellow and blue pair, positive value refer to yellow shade and negative value refer to blue shade of substance.

Figure 2 presents comparing of a^* value between control, color-treated and untreated. The red color are measured from spectrophotometer and determine by a^* value that showed positive. There are significantly different on red hue between color-treated group and untreated group. Untreated sample shows decreasing value of a^* scale that can refer to fading of red color after washing procedure. Red dye or auburn hair dyes have been shown to fade more than other shades because it is more water soluble and greater removed during washes, resulting in shade changes by surfactants present in shampoo formulations provide a wetting function which brings moisture into the hair shaft, thus facilitating the removal of the dye molecules to exit during the water rinsing process (Zhou et al. 2009).

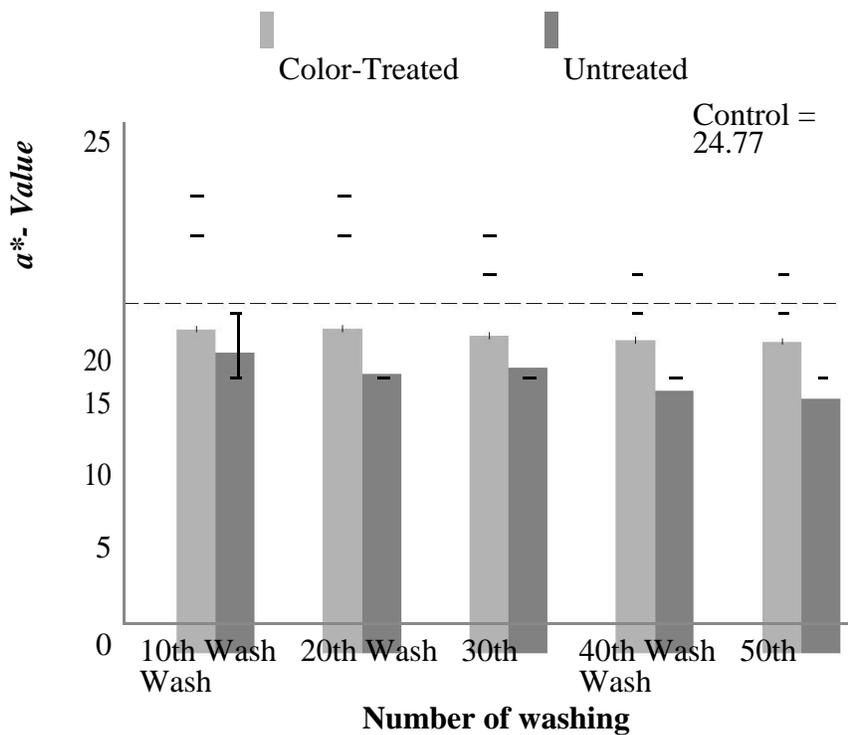


Figure 2 a*-Value comparative between control, untreated and color-treated by using Chroma meter.

Discussion and Conclusion :

Washing procedure is a factor what influence fading in artificial hair color in routine washing but conditioner with dye pigment or color treatment product are able to maintain artificial hair color with lower different from the first color after dyed hair when compare with basic conditioner until re-colorant by using direct color adding that replace faded shade in developed formula.

From the result shows lower fading of a*-value or red hue significantly in color-treated group when compared with untreated group. Untreated sample show continuous fading in a*-scale in every 10 washes but in color-treated group shows similar value in a* scale, a*- value in color-treated group show lower percent change at 50th wash from control when compare with untreated in the same condition.

Semi-permanent hair dyes are used in conditioner formula because they are direct dye without using oxidation agent with para-dye in permanent hair dye that can cause irritate and not suitable for using daily (Gray 2001) and semi- permanent hair dye was minimal damaged to hair shaft (Bolduc and Shapiro 2001). That is limitation about dye pigment that use in experiment, adding color in conditioner does not contain some red shade of permanent hair dye that may affect to result in ΔE between control and color-treated sample. However, there is significantly different of hair color after washing between color-treated and untreated sample group, the color-treated group show smaller amount of ΔE than untreated group and able to determine that the

color-treated group have lower of color difference from control than untreated group.

For the suggestion, The compatibility of first dye and adding pigment in treatment may enhance smaller value of ΔE and help to maintain artificial hair color with brighten and shine in right shade that client needs.

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