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Natural hair dye from heartwood of *Haematoxylon campechianum* (Linn.) plant

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Abstract
Heartwood of *Haematoxylon campechianum* (Linn.) yielded natural dyes as propylene glycol and menthol in henna were carried out 8 times of shampoo dyeing. Experimental results showed that the 'L' value (colour lightness change) of dyes hair pieces containing 5% and 7 % *Haematoxylon campechianum* (Linn.) were 32.2% and 30.4% respectively. Addition of 7% Logwood dye extract in hair to coat on 3 groups of hair pieces which showed that there is no significant difference (P>0.005) between ΔE mean value 16.68 ±0.3 of 3 groups of hair pieces after 8 shampoos and ΔE mean value 16.29 ±0.40 of the 7th shampoo. Results showed that the degree of hair colour fading tends to be smorth after 7th shampoo. The 'L' mean value 33.35% of 8th shampoo is significantly different from the 56.34 of bleached hair colour, indicating that after 8th shampoos, the hair colour lightness can still fade. The $^{*}a^{*}$ and $^{*}b^{*}$ mean values decrease from 12.96% and 11.58% after 1st shampoo to 3.34% and 7.78% after the 8th shampoo and the hair colour obviously changes from red to brown. This hair dye increases the tensile strength of the bleached hair by 53.68%. The experiments proved that the henna mixed with *Haematoxylon campechianum* (Linn.) wood dye like propylene glycol and menthol can withstand more than 8 times of shampooing and it can effectively cover white hair and strengthen hair.

Keywords: *haematoxylon campechianum* (linn.), heartwood hair colour dye, propylene glycol and menthol

Introduction
Haematoxylon campechianum (Linn.) plant [1] belongs to the family Papilionaceae or Fabaceae and commonly known as blood wood, logwood, Campeche and black wood. It is a small bushy tree upto 5-15m in height. It occurs in all over India, Central America, Southern Africa, Brazil, China, Mexico, Turkey, Fiji, Indonesia, Malaysia, Philippines, Singapore, etc. Logwood is a valuable dyewood and largely used in the preparation of ink and to a small extent in medicine, it is used as an astringent and ionic for dysentery, diarrhoea and leucoderma. An ointment prepared from the wood is said to be useful against cancer and gangrene and anti-inflammatory properties. Wood yielded a series of dyes in darker tints of grey, brown, violet, blue and black. Dyes give a fairly permanent colour to several fabrics such as Silk, wool and cotton but also to synthetics as nylon and rayon. They may be used to dye leather as well as fur, feathers, paper, bone and also in the manufacture of inks. The extract from its wood and bark create an excellent deep colour stain, which is mostly used in cell and clothes dyeing. Present investigation deals with the using of henna for hair dyeing with *Haematoxylon campechianum* (Linn.) dye from heartwood extract as: Propylene glycol and menthol in order to evaluate hair dyeing fastness.

The semi-permanent hair dyes can be divided into three types as acidic, basic and disperse dyes. Molecular size of acidic dyes is large and unlikely to penetrate the cortical layer of hair and dyeing fastness of acidic hair dye is better than that of other semi-permanent hair dye. However, the anionic nature of the acidic dye may cause damage of hair quality. Uses of disperse dyes and basic dyes, acidic dyes, alkaline agents and multivalent phenol are commonly used in hair dyes [2]. There are few current studies related to the penetration mechanism of natural dye. Propylene glycol is used as a solvent in preparation to help active ingredients permeate and has been proven effective for promoting the penetration of many kinds of drugs. Menthol is a keto penetration enhancer of Terpenes, which promotes the penetration of Meloxican indomethacin and Tamoxifen drugs used in percutaneous absorption system [3, 4]. Menthol (2%) and propylene glycol (2%) can increase the percutaneous rate of fast acting slimming plasters by 1.50 times. According to FT-IR, menthol increases the penetration modes of tamoxifen, but not the distribution of tamoxifen in the harny layer [5].

Hair is a very tensile fibre and can endure a force to 12kg/nm^2 (12×10^7 Pa) and its maximum load is larger than that of aluminium. Improper hair perming and dyeing may affect the elasticity of the hair [6]. In addition to being used as skin and hair dyes, henna can be used as medicine for skin tinea [7]. *Eucalyptus*, oleic acid and propylene glycol dyeing accelerants at 1% concentration were added in henna to hair dye and results showed that the propylene glycol has best dyeing effects.

Materials and Methods
Extraction of Dye from Heartwood
The heartwood (250 gm) of *Haematoxylon campechianum* (Linn.) was immersed in distilled water (6 litre) for 2 hrs and boiled until the water volume reduced to one-fourth volume of the original. Water (3 litre) was then added to continue boiling and the process repeated twice times then filter paper was used for the filtration. The vacuum pressure reduction

concentration was used for dyeing and solution was then diluted to 10% of *Haematoxylon campechianum* (Linn.) heartwood dye extract for future uses.

Preparation of Hair Pieces

The hair pieces about 26 cm wide, 40 cm long and 0.4-0.8 cm thick were bleached with shampoo Loreal. Platifiz Precision and mixed uniformly with 9% hydrogen peroxide in 1:2 molar ratio with three times where each bleaching lasted 30 min and the hair pieces were then rinsed with tap water, dried and then uses for future studies.

Preparation of *Haematoxylon campechianum* (Linn.) Hair Dye

Haematoxylon campechianum (Linn.) dye (10%) and Henna powder then pure water added to formulas A and B to 100 gm in ratio. Propylene glycol (2 gm) and menthol (2 gm) were added to homogenize at 300Δ for 5 min. then dyeing brush was used to coat the mixture on the hair from top to bottom. The hair pieces set at room temperature for 1 hr and then rinsed in water and dried. The CIE, L^* value represents the colour lightness changes thus hair dyeing can be identified by the L^* value. The natural dye adhered to the hair surface between 1st and 4th shampoo and the dyeing situation cannot be identified. This study used those with low L^* values after the 8th shampoo as the formula concentration for subsequent research. Henna powder mixed with pure water in 15:85 molar ratio was the central group. In order to determine the effect of dyeing while hair, a small portion of hair containing white hair (70%) was used for the experimental purposes.

Water Washing and CIE L^*, 'a' and 'b' Values

The dyed hair was placed in a conical flask 500 ml with periodically shaking at constant temperature for 8 min. with 200 rpm oscillation frequency. The hair dye was rinsed and 400 ml tap water was added then oscillated for 5 min. The hair was washed twice time under the same water washing conditions. Hair was removed in hair conditioner (1%) for 2 min. and rinsed with tap water then placed in a moisture proof box.

A colour difference meter (X-Rite Sphere Spectrophotometer Sp 60) was used to measure the five points of dyed hair pieces β-1, β-2 & β-3 in order to determine the mean value and standard deviation then analyze CIE (International Commission of Illumination) L^*, 'a' and 'b' ('a'= green red axis and 'b'= blue yellow axis) and colour differences ΔE values. The ΔE value increases as the number of shampoos increased this a larger colour differences means a larger difference between colour and higher fading rates.

In addition to the dyeing effect was determined according to the degree of variation in $^*L^*$ value (Colour lightness change) and 'a' and 'b' values (a=green red axis and b=blue yellow axis). The colour difference ΔE value in this study was obtained from the following formula.

$$\Delta E = [(L_2-L_1)^2 + (a_2-a_1)^2 + (b_2-b_1)^2]^{1/2}$$

Hair Strength Analysis

Tensile method was conducted to observe the variation in the hair strength after dyeing. Thickness gauge (TELOCK SM-1201) was used to measure the diameter of three hair samples selected from each group of hair pieces. A tensile strength tester (i.e. Microcomputer tensile strength tester GT-7010 DI-PC) was used to test the tensile force. Record the main value of destruction work and determine the standard deviation and the fibre breaking strength of each sectional areas. The fibre breaking strength was compared to determine whether the hair quality is affected.

Results and Discussion

Haematoxylon campechianum (Linn.) dye was diluted with water to 1% concentration and results are shown by UV/VIS Spectrogram and main wavelength absorption peak of heartwood dye was 434nm. The L^* value of henna dye of the central group after 8th shampoos was 55.28% which is an insignificant difference as compared with 54.38% after dyeing. This result showed that the dyeing affect of henna dye is poor. Experimental results showed that the L^0 values of two groups of hair pieces of A and B formulae after 8th shampoos were 32.2 and 30.4 respectively. The bleached hair colour (L^*=59.6), the L^* value of formula B with 7% dye is better. The formula-B was used for hair pieces B-1, B-2 and B-3 as experimental group. Results compared with L^* value of the control group and found that when henna is added with Logwood dye after 8th shampoos. The L^* value of dyed hair (30.2) was lower than that of without Logwood dye and results proved that henna with Logwood dye can deepen dyed hair colour.

The three groups of hair pieces after 8th shampoos are 16.28%, 16.86% and 16.92% indicating that the colour differences of ΔE values of three groups of hair pieces are 98%, proved to have good accuracy. The ΔE mean values of 8th and 6th shampoo of experimental group were compared and results showed a significant difference ($P<0.05$). However, there is no significant differences ($P>0.05$) between colour difference ΔE mean values of 8th and 7th shampoos. This difference means that the hair piece colour continues fade after 6th shampoo; after 7th shampoo, the hair fading slows down and presents a stable with no obvious fading. Therefore, the three groups of hair pieces after 8th shampoo of dyed hair pieces have good dyeing fastness and several shampoos allowed.

The results of this study suggested that henna dye only adheres to the hair cuticle and it cannot permeate into hair cortex. However, when *Haematoxylon campechianum* (Linn.) dye as propylene glycol and menthol are added in the red effect on hair is strengthened and hair odour is deepened after 8th shampoos. The white hair is dyed with a semi-permanent hair dye containing *Sapwood* dye. According to the preliminary check after 8th shampoos, the semi-permanent hair dye formula can effectively cover white hair and has an excellent dyeing affect when henna is mixed *Haematoxylon campechianum* (Linn.) dye. The hair dye allowed more than 8th shampoos, the colour will change from red to brown. This showed that the colour of hair did not change, thus the colour of hair piece might be affected by water quality.

The hair strength is determined by hair cortex, improper dyeing and ultraviolet radiation may cause damage to the hair [8, 9]. This study attempted to discuss whether the formula of experimental group decrease hair strength. The colour difference ΔE value of hair pieces B-1 after 4th and 8th

shampoos was better than both B-2. The henna mixed *Haematoxylon campechianum* (Linn.) dye extract can strengthen bleached by 53.68%. The dye from heartwood can be used in semi-permanent hair dyes and it can cover white hair.

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