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Extraction of Dye from Natural Source (LAC) & its Application on Leather

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Abstract

The aspect of dyeing leather without hampering the environment and human health is a burning issue since the last century. This study was an endeavor to introduce a convenient natural dye from the insect of Cocus Lacca for dyeing leather in an eco-friendly way. The effect of process parameters of dyeing viz. pH, temperature, time duration, exhaustion of color, shade brightness, color fastness etc. had been studied. Result showed that the optimum extraction was 4% at 90°C. The pH of the developed dye was 6.5 and optimum time of dye exhaustion was 80 minutes. The extracted dye was applied on split leather with and without mordant. It was found that mordant has a significant effect on the color of leather. Ferrous Sulfate ($FeSO_4$) mordant showed more excellence. Future research on the same field using different extraction methods, different mordants, and mordanting methods will optimize the results of the current study.

Keywords: Mordant; Dyeing; Cocus Lacca; Natural dye; Leather; Eco-friendly.

1. Introduction

Leather is an incredibly wonderful natural fabric which has been used for thousands of years in making garments, gloves, shoes, wallets, suitcases, upholstery, sporting goods, book covers & much more. Synthetic dyes are generally used for the dyeing of leather in industries. Synthetic dyes are harmful to human beings & to the environment as most of these dyes are carcinogenic and allergic [1].

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Western country's consumers have become more concerned about the health issues and the environmental impact of synthetic dyes [2]. Thus, there is a growing demand of products that use Natural dyes. In the beginning of the twenty first century, the market for natural dyes in the fashion industry is experiencing resurgence [3]. Natural dyes are dyes or colorants derived from plants, invertebrates, or minerals [4]. The majority of natural dyes are vegetable dyes from plant sources i.e. roots, berries, barks, leaves, wood and other biological sources such as fungi & lichens [5]. Better bio-degradability, non-toxic and eco-friendly properties of these dyes make them popular among nature loving and health conscious people around the world [6]. The other benefits of using natural dyes are that it significantly cuts down the amount of toxic effluent resulting from the synthetic dye processes. As against synthetic dyes derived from non-renewable resources, natural dye is from an excellent renewable resource if proper cultivation of such vegetable kingdom is executed [7].

Lac is a potential source of extracting natural dye, obtained from an insect Cocus Lacca (Lacciferlacca Kerr). The insect produces a resin known as stick lac. Lac dye or laccaic acid represents approximately 0.5-0.75% by weight of stick lac [8-11].

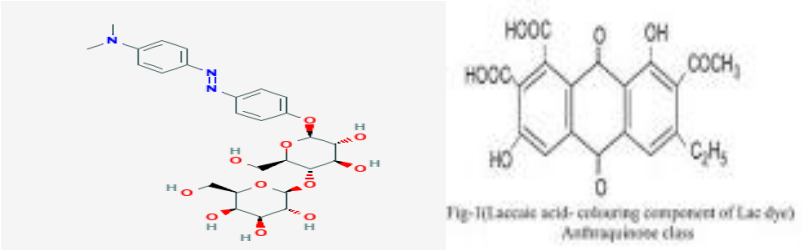

Fig-1(Laccaic acid- colouring component of Lac dye)
Anthraquinone class

Figure 1

2. Materials and Methods

2.1 Sample Collection

Lac dye is red in color and obtained from female insects Cocus Laccae. It is abundantly found northern part of Bangladesh particularly Nachole Upozilla in Chapai Nawabganj district. The raw material was collected from that area which is available in the local market. It can also be collected easily by contacting with the farmers who are engaged in cultivation of Lac (locally known as Lakkha).

2.2 Sample Preparation

For the extraction of dyestuff Lac was immersed in a water solution for 8 hours and heated at 90^{o}C for 45 minutes. Then the solution was filtrated using a whattman filter paper (grade 1). The filtrate was transferred to a beaker and stored into a glass bottle under 4^{o}C temperature. The optimum extraction was 4% for applying in the dyeing experiment.

After extraction, the dye was applied on leather. The application of dye does not require any change in the normal dying operation of leather. The volume of the dye solution in the leather dyeing experiment was

calculated to a fixed concentration of 6% dye for all of the dyeing experiment (based on the leather weight).Three different types of mordants viz. Ferrous Sulphate, Magnesium Sulphate, Aluminium Sulphate were used for various shades.

3. Results and Discussion

Different physical parameters of the extracted dye were determined cautiously. Lac dye possesses approximately the same properties like other natural dyes. The P^H of lac dye is acidic in nature which is very suitable for leather dyeing.

Table 1: The pH and Ash content of the developed dye

The name of the dye	pH	Total Ash (%)	Color with Ferric Chloride
Lac dye	6.5	5	Light blue

The process of transfer of dyestuff from the dye bath on to the fiber or material is known as exhaustion. The exhaustion of dye was also tested to assess the actual rate of exhaustion whose data has been illustrated below.

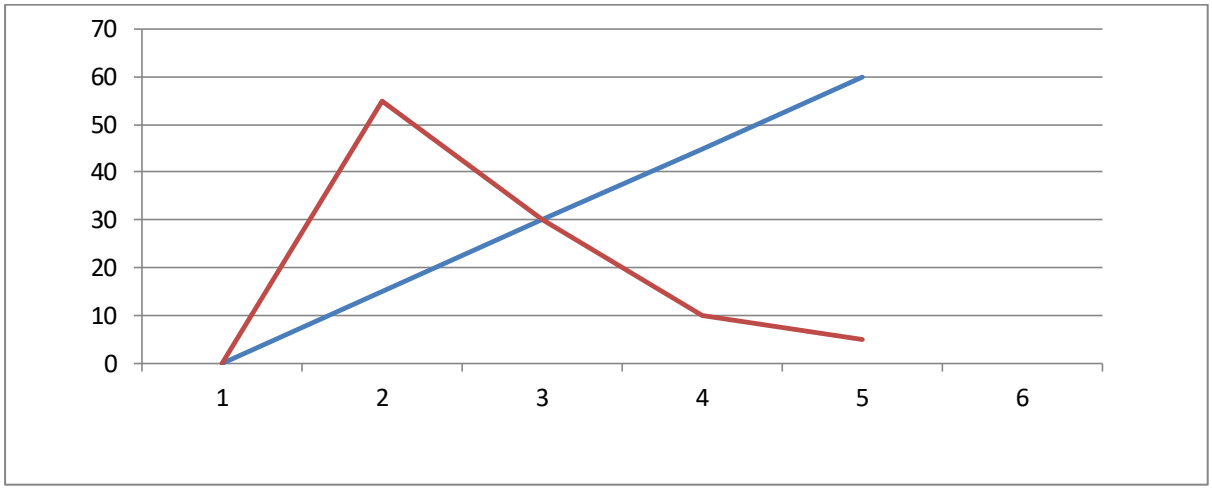

Figure 2: Color exhaustion of Lac dye

In the vertical line % of exhaustion & in the horizontal line time are shown (four segments of one hour) - Lac dye. After 15 minutes of applying the dye on leather the absorption was 54 % (as shown in the red colored line on the above figure). The result was checked during the dyeing period. The dye absorption was 30%, 10% and 6% in a time interval 30, 45 and 60 minutes respectively. The visual assessment of the dyed leather was very fantastic. The leather samples were tested by X-rites color tester following the CIA system. Here L^* denotes lightness, a^* & b^* represents red/green coordinates & yellow/blue coordinates respectably. Whereas, c^* denotes the Chroma and h^* denotes the Hue angle.

Mo Mordant | Ferrous Sulphate

Aluminum Sulphate | Magnesium Sulphate

Figure 3: Application of lac dye with and without mordant on leather.

Table 2: X-rite color test report after applying the dye on split leather.

Mordant types	k/s	Color strength %	Color co-ordinate				
			L*`	a*	b*	c*	h*
No mordant	1.2145	88	60.12	4.96	9.89	11.05	61.62
Ferrous Sulphate	1.1589	83	47.18	4.16	9.00	9.91	65.16
Aluminum Sulphate	1.1589	91	54.78	5.76	9.87	11.43	59.71
Magnesium Sulphate	0.8596	89	50.55	4.02	5.93	10.15	61.62

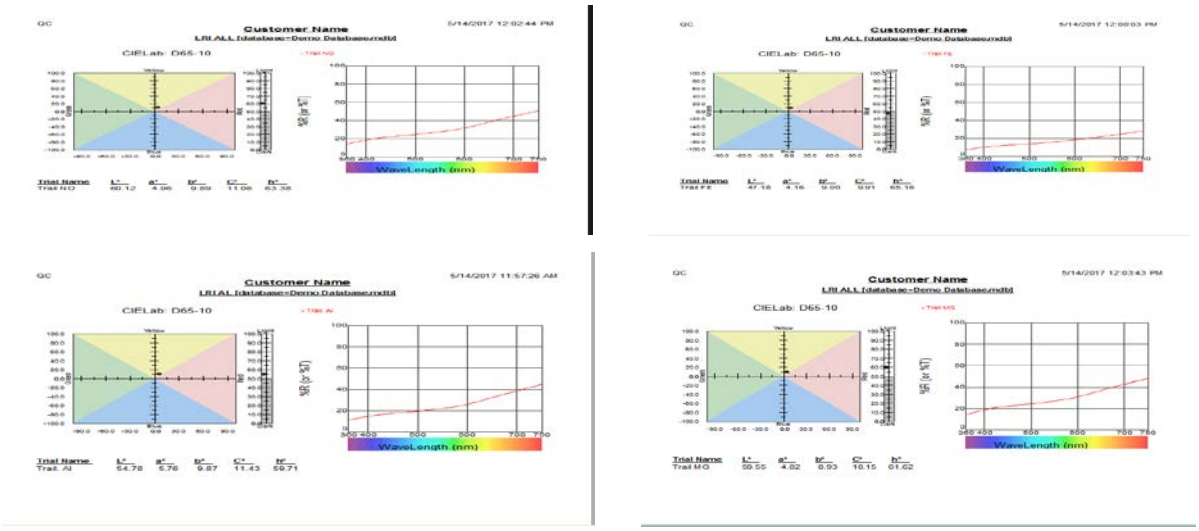

Figure 4: Image obtained in X-rite color test

The color rub fastness test is one of the important criteria for assessing leather dyeing quality [12]. So, the samples were tested according to SATRA PM 08 (norm) [13]. The wash fastness test and light fastness test were also performed following the standard procedure.

Table 3: Different fastness properties report of dyed split leather

Varieties of Leather	Rub fastness test	Wash fastness test	Light fastness test
No Mordant	4/5	4	4
Ferrous Sulphate	4	4/5	4
Aluminum Sulphate	4	4/5	4/5
Magnesium Sulphate	4	4/5	4

Strength property and percentage(%) of Elongation were also determined by following the IUP-06 [14].

Table 4: Strength property of the dyed leather.

Varieties of Leather	Tensile Strength (Kg/cm^2)	% of Elongation
No Mordant	84.71	45.46
Ferrous Sulphate	70.99	42.31
Aluminum Sulphate	94.63	35.32
Magnesium Sulphate	73.51	36.24

FT-IR spectrum was done of the extracted lac dye for identification of functional groups. The spectra region 3600-3200 cm^{-1}, 3100-2800 cm^{-1}, 1740-1640 cm^{-1},1650-1600 cm^{-1}, 1480-1300 cm^{-1}, 1300-900 cm^{-1} show the presence of O-H, C-H, C-O, C-C stretching band, C-H bending band and C-O stretching band respectively.

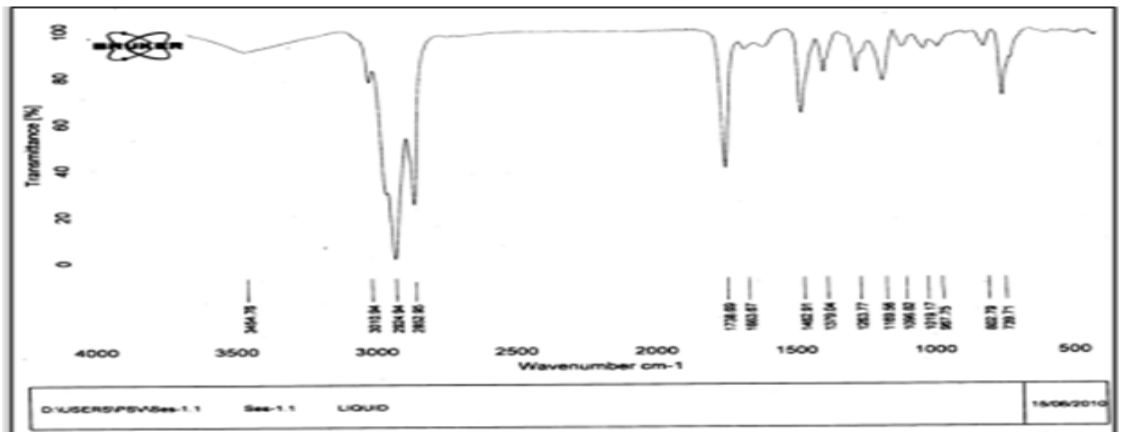

Figure 5: Spectral analysis FTIR (Lac dye)

Figure 6: Developed products by using Lac dye

4. Conclusion

Leather is a precious material posing high value addition both in national and international perspectives [15]. It can successfully be dyed with lac dye using different mordant to obtain range of shades which are reasonably fast on leather. The lac dye is obtained from a pure cultivable product which is available in abundance. Color strength of leather sample dyed with lac dye showed brilliancy in color fastness. So, the lac dye can be one of the convenient sources of eco-friendly dye in leather processing operation.

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