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# Floral Dyes: An Opportunity for Punjab Leather Industry to Promote Sustainable Fashion Development

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**Abstract-**Natural dyes are considered nature friendly and sustainable as compared to synthetic dyes. Therefore, the present study was designed to extract eco-friendly natural dyes from easily and abundantly available flowers of Punjab and investigated their colouring ability on chrome tanned goat crust leather. In this study, an attempt has been made to produce a variety of shades using natural dye of *Celosia cristata* Linn., *Lantana camara* Linn., *Rosa damascena* and *Tagetes erecta* L. with and without mordants. Forty different shades were obtained with mordants and four shades were obtained without mordants. CIELab values of all dyed leather specimens were measured in terms of (L*, a*, b*) using a Spectrophotometer (Spectraflash SF-650X). The findings of the study revealed that developed fashion shades found fair to good in terms of dye evenness. Moreover, this study would be served as a shade catalogue guide and an opportunity for leather industries to promote sustainable fashion development.

**Index Terms-** Eco-friendly; Fashion industry; Flower; Leather industry; Natural dyes

## 1. INTRODUCTION

Natural dyes were used for leather coloration till the middle of the 19th century [1] and the era of synthetic dyes started in 1856 when William Henry Perkin advented ‘Mauveine’ a synthetic dye which replaced and reduced the consumption of natural dyes [2, 3]. Excessive use of synthetic dyes in leather industries has adverse impacts on human health and the environment [4]. Furthermore, the ban on the use of synthetic dyes has pushed out global market to reintroduce eco-friendly dyes to reduce industrial pollution and minimize health risks [5, 6]. Nowadays, natural dyes are consumer’s demand due to their several benefits [7] over synthetic dyes [8]. Natural dyes are renewable, easily available, compatible with the environment [9, 10], non-carcinogenic, non- toxic [11], biodegradable [12], sustainable, have a variety of fashion colours [13, 14, 15], safe for ecology, human health [3] and above all floral extract is considered economical [16].

In view of the above, this study was carried out in Punjab, Pakistan, which is the richest and most diversified province of Pakistan in terms of plant diversity [17]. Punjab has a flourishing leather industry, which contributes significantly to the national economy. The province is fortunate in having abundant raw material for leather industry. Local availability of raw material for leather sector is having a significant effect on the job market of Punjab as leather is labour intensive sector and 75% exporters of leather are based in Punjab [18]. Hence, keeping into account the economic importance of the leather industry, growing concerns of eco-safety and impairment of human health, the present study is designed to investigate the indigenous flowers of Punjab as a source of natural dyes. The objectives of this study were: (i) to assess the colouring ability of floral dyes such as *Celosia cristata* Linn., *Lantana camara* Linn., *Rosa damascena* and *Tagetes erecta* L. on chrome tanned goat crust leather (ii) to develop a shade catalogue of dyed leather specimens (iii) to determine the CIELab values of all dyed leather specimens.

## 2. MATERIALS AND METHODS

### 2.1. *Leather*

Chrome tanned goat crust leather was selected for dyeing analysis which purchased from the local tannery of Sialkot, Punjab.

### 2.2. *Flowers*

Four varieties of flowers *i.e. C. cristata*, *L. camara, R. damascena* and *T. erecta* were collected from the “Jinnah Garden”, Lahore, Punjab on the basis of their abundance and ease of availability (Figure 1). A voucher specimen of selected flowers was submitted in the Herbarium of Botany Department, Lahore College for Women, University for identification.

*Celosia cristata* *Lantana camara* *Rosa damascena* *Tagetes erecta*

Figure.1 Flowers used for extraction of dye.

**2.3. *Chemicals & mordants***

The commercial grade chemicals *i.e.* sodium formate (HCOONa), sodium bicarbonate ($NaHCO_3$), sodium hydroxide (NaOH), formic acid ($CH_2O_2$), and the ten different synthetic mordants i.e. potash alum ($KAl(SO_4)_2$), potassium dichromate ($K_2Cr_2O_7$), aluminium sulphate ($Al_2(SO_4)_3$), copper sulphate ($CuSO_4$), ferrous sulphate ($FeSO_4$), copper chloride ($CuCl_2$), ferric chloride ($FeCl_3$), copper acetate ($Cu(CH_3COO)_2$), acetic acid ($CH_3COOH$), and tartaric acid ($C_4H_6O_6$) were used in the study.

**2.4. *Apparatus & Equipment***

Micro steel drum was used for pre-mordanting and dyeing of leather. The drum is equipped with a control panel having a display of temperature, speed of circulation and time [19]. The spectrophotometer (Spectraflash SF-650X) was used for the measurement of CIELab values (L*, a*, b*) of the dyed leather specimens. Through L*, a* and b* values it can be analyzed that higher values of L* show light shades while low values of L* signify dark shades. Whereas, -a* implies green colour, +a* demonstrates red colour, -b* infers blue, and +b* depicts yellow colour [20].

**2.5. *Dye extraction***

First of all, petals were separated from the plucked flowers, weighed and rinsed thoroughly with tap water to remove dirt and impurities. In order to extract dyes from the selected flower petals, the aqueous method was carried out using1:10 M:L ratio. The raw material was soaked in distilled water and kept at room temperature for 3 days. Afterwards, the extracted dyes were filtered to remove residues and impurities using Whatman filter paper No. 1.

**2.6. *Leather dyeing***

The leather dyeing procedure is listed in the Table 1.

Table 1. Leather dyeing procedure.

| **Process** | **Products and time duration** |
|---|---|
| Wetback | 10 g crust leather was dipped in 800 mL of water overnight. Next day, the substrate was treated with the 1% solution of sodium formate (HCOONa) and sodium bicarbonate ($NaHCO_3$) in 250 mL water for 30 minutes in micro steel drum. Thereafter, the sample was rinsed with tap water. |
| Pre-Mordanting | Wetback crust leather was treated with 1M solution of each mordant for 60 minutes. |
| Dyeing (First Phase) | Mordanted leather was dyed with 250 mL of extracted liquid dye at pH 8.0 for 30 minutes. After half an hour, the pH of the dye bath was adjusted at 3.0 by adding ($CH_2O_2$), then it was dyed for further 30 minutes. |
| Dyeing (Second Phase) | Repeated the same process of dyeing with the new addition of 250 mL of extracted liquid dye from flower petals. |
| Drying | The dyed leather specimens were dried under shade. |

## 3. RESULTS AND DISCUSSION

**3.1. *Aqueous dye extraction method***

It was analyzed from the results that simple aqueous dye extraction method was found suitable which was known as effective, efficient and low cost [21, 22]. Similarly, on the other side the selected plants (flower's petals) were found economical and also reported as a cheap raw material for natural dye extractions [23].

**3.2. *Shades obtained without mordants***

It was clearly observed from the results presented in Table 2 that unmordanted dyed leather specimens exhibited beautiful shades after dyeing with the dyes extracted from *C. cristata, L. camara, R. damascena and T. erecta.* Analyzing results of without mordant given in Table 2, it has been found that acceptable evenness of dyes was obtained on both sides (grain and flesh) of leather specimens. Whilst, four different developed shades such as pink, olive green, grey and yellow were inspiring. By further examining the properties of shades, it has been noticed that among four varieties of floral dyes, the *R.damascena* dye was the most dominant natural dye to produce deep shades on leather specimens.

Table 2. Shade catalogue of dyed leather specimens with *C. cristata, L. camara, R. damascena and T. erecta* dyes.

| **Flowers used** | ***C. cristata*** | ***L. camara*** | ***R. damascena*** | ***T. erecta*** |
|---|---|---|---|---|
| Without Mordant | | | | |
| With Mordants | | | | |
| Potash alum | | | | |
| Potassium dichromate | | | | |
| Aluminium sulphate | | | | |
| Copper sulphate | | | | |
| Ferrous sulphate | | | | |
| Copper chloride | | | | |
| Ferric chloride | | | | |
| Copper acetate | | | | |
| Acetic acid | | | | |
| Tartaric acid | | | | |

### 3.3. *Shades obtained with mordants*

The application of ten different synthetic mordants produced a variety of shades on leather specimens which can be clearly analyzed from the results of Table 2. Developed shades also produced good bonding with used mordants which was the significant reported quality of synthetic mordants [24, 11]. Earlier study [20] reported the similar results obtained on leather with henna dyeing. Moreover, potash alum, aluminium sulphate, copper sulphate, acetic acid and tartaric acid mordants exhibited soft fashion shades with *C. cristata, L. camara* and *T. erecta* dyes [25].

From Table 2, it can be revealed that eye catching shades obtained were: beige, grey, pink, yellow, light brown, camel brown, pale yellow, golden yellow, vivid yellow and the cardamom green. Potasium dichromate produced beige colour and showed good bonding with *L. camara and R. damascena* dye. The similar findings of obtained beige shade were reported on cotton and leather [26, 27]. The shades of grey were obtained with ferrous sulphate which was the known quality of the mordant to give grey colours [28]. Potash alum, copper sulphate, and ferrous sulphate mordants produced significant dye shades which were known as nature friendly mordants [29, 30]. In addition, copper sulphate and ferrous sulphate chelated a good tendency with produced dyes and similar findings have been reported to develop strong bonding with dyes in earlier study [31]. Hence, the present research elucidated that leather dyed with *C. cristata, L. camara, R. damascena and T. erecta* exhibited light and dark shades with mordants. From the comparative analysis of all shades, it has been found that most of the dark and deep shades were obtained with *R. damascena* dye. Moreover, visualizing the shades obtained with *C. cristata* dye, it has been observed that all dyed specimens were found in light, subtle and soft pleasing shades. While the *L. camara* dye produced different tones of brownish, yellow and light greenish colours. In addition, *T. erecta* was found dominant to develop reported yellow, beige, greeinsh yellow and olive green shades [32].

Table 3. CIELab values of leather dyed specimens with *C. cristata*, *L. camara*, *R. damascena and T. erecta dyes*.

| **Mordants used** | ***C. cristata*** | | | ***L. camara*** | | | ***R. damascena*** | | | ***T. erecta*** | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **L*** | **a*** | **b*** | **L*** | **a*** | **b*** | **L*** | **a*** | **b*** | **L*** | **a*** | **b*** |
| Without mordant | 65.62 | 5.00 | 2.09 | 67.14 | -4.12 | 15.27 | 49.05 | -0.85 | 2.45 | 74.06 | -3.34 | 18.10 |
| Potash alum | 67.82 | 1.93 | 6.00 | 65.94 | -4.15 | 5.58 | 65.94 | -4.15 | 5.58 | 78.06 | -5.22 | 23.88 |
| Potassium dichromate | 71.46 | -0.56 | 14.08 | 60.92 | 3.65 | 24.84 | 65.51 | 1.30 | 24.77 | 75.50 | -1.23 | 16.38 |
| Aluminium sulphate | 68.74 | 1.50 | 6.02 | 65.08 | -3.58 | 13.94 | 65.08 | -3.58 | 13.94 | 78.59 | -5.60 | 23.97 |
| Copper sulphate | 70.27 | -5.72 | 20.18 | 71.04 | -3.71 | 12.91 | 62.66 | -2.85 | 13.39 | 75.42 | -3.83 | 16.06 |
| Ferrous sulphate | 66.93 | -0.52 | 9.75 | 57.81 | -1.86 | 13.01 | 47.55 | -1.36 | 7.50 | 58.67 | -1.34 | 10.52 |
| Copper chloride | 68.77 | 1.30 | 9.74 | 71.59 | -4.06 | 17.73 | 58.56 | -1.43 | 5.72 | 58.66 | 0.80 | 10.46 |
| Ferric chloride | 64.83 | 1.06 | 13.84 | 55.23 | -0.55 | 13.96 | 41.73 | -1.14 | -2.21 | 79.00 | -2.68 | 9.78 |
| Copper acetate | 61.53 | -0.08 | 6.77 | 71.36 | -4.09 | 16.68 | 67.55 | -2.53 | 8.91 | 76.89 | -3.69 | 15.09 |
| Acetic acid | 65.58 | 1.20 | 9.87 | 69.99 | -4.98 | 15.28 | 65.73 | -2.39 | 8.87 | 75.11 | -4.00 | 23.96 |
| Tartaric acid | 69.14 | -0.22 | 9.46 | 66.03 | -3.03 | 10.62 | 55.41 | 2.31 | 5.72 | 75.65 | -2.82 | 13.63 |

### 3.4. *CIELab values*

Comparing the CIELab values of all dyed leather specimens, the variation in L*, a*, b* values were clearly seen with and without mordants.

Based upon results of *C. cristata* presented in Table 3, the lowest L* value 61.53 produced with copper acetate while the highest L* value 71.46 developed with potassium dichromate. Assessing results of a*, the lowest value -0.56 (most green) was developed with potassium dichromate whereas highest value of a* 5.00 was obtained without mordant. Similarly, analyzing results of b*, the lowest value 2.09 was produced without mordant whereas highest value of b* 20.18 (most yellow) was developed with copper sulphate. Overall, the obtained L* values with this extract using ten different mordants were found very high.

In the case of *L. camara* results given in Table 3, ferric chloride produced lowest value of L* 55.23 (darkest) whereas copper chloride developed highest L* value 71.59 (lightest). Analyzing a* values, it has been noticed that acetic acid depicted lowest value of a* -4.98 (most green) while potassium dichromate displayed highest value of a* 3.65. Similarly, observing b* values, potash alum produced lowest value of b* 5.58 whereas potassium dichromate depicted maximum value of b* 24.84 (most yellow).

With *L. camara* dye, it has been analyzed that wide spectrum of b* values were found in positive range whereas most of a* values were found in negative form which were clearly showing the shade trends towards green colour.

Analyzing the results of *R. damascena* in Table 3, it was found that low L* values were obtained with ferrous sulphate (47.55), ferric chloride (41.73), copper chloride (58.56), tartaric acid (55.41) and without mordant (49.05). Observing a* values, it was noticed that minimum value of a* -4.15 (most green) was obtained with potash alum and maximum value of a* 2.31 (most red) was depicted with tartaric acid. In case of b* values, minimum value of b* -2.21 (most blue) was displayed with ferric chloride and maximum value of b* 24.77 (most yellow) was developed with potassium dichromate.

Assessing the results of *T. erecta* in Table 3, it has been revealed that minimum value of L* 58.66 (darkest) was obtained with copper chloride and maximum value of L* 79.00 (lightest) was recorded with ferric chloride. Observing a* values, minimum value of a* -5.60 (most green) was found with aluminium sulphate and maximum value of a* 0.80 (most red) was reported with copper chloride. Analyzing b* values, minimum value of b* 9.78 was observed with ferric chloride whereas maximum value of b* 23.97 (most yellow) was achieved with aluminium sulphate.

## 4. CONCLUSIONS

This study is the first one in Punjab to investigate the application of floral dyes on chrome tanned goat crust leather. In Punjab, the abundantly available flowering plants can be served as a major source of environment friendly dyeing agents and have great potential of using non-toxic colourant for leather dyeing. Results of the study revealed that a good variety of forty splendid shades can be produced using floral dyes with synthetic mordants. On the other hand, the unmordanted dyed leather specimens also rendered good quality results. It is also notable from the obtained findings that aqueous dye extraction process is eco-friendly and economically viable. Thus, it was concluded from the findings that the produced floral dyes from selected flower's petals are well suited for leather dyeing and the developed shade catalogue is a new addition in eco-friendly leather dyes to promote sustainable fashion development.

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## REFERENCES

[1] Frey, S. M. (1981). The chemistry of plant and animal dyes. Journal of Chemical Education, **58**(4), 310-305.

[2] Chengaiah, B., Rao, K. M., Kumar, K. M., Alagusundaran, M., Chetty, C. M. (2010). Medicinal importance of natural dyes- a review. International Journal of Pharm Tech Research, **2**(1), 144-154.

[3] Shahid, M., Mohammad, F. (2013). Recent advancements in natural dye applications: a review. Journal of Cleaner Production, **53,** 310-331.

[4] Abramian, L., El-Rassy, H. (2009). Adsorption kinetics and the modynamics of azo-dye Orange II onto highly porous titania aerogel. Chemical Engineering Journal, **150**(2), 403-410.

[5] Iqbal, M. J., Ashiq, M. N. (2007). Adsorption of dyes from aqueous solutions on activated charcoal. Journal of Hazardous Materials, **139**(1), 57-66.

[6] Kadolph, S. (2008). Natural Dyes: A traditional craft experiencing new attention. Delta Kappa Gamma Bulletin, **75**(1).

[7] Haji, A., Amiri, Z., Qavarmnia, S., S. (2014). Natural dyeing of wool with Arnebia euchroma optimized by plasma treatment and response surface methodology. Journal of Biodiversity and Environmental Science, **5**(2), 493-498.

[8] Parthasarathi, B., Lokesh, P. (2015). A case study of natural dye extraction and phytochemical screening using the flower Spathodea campanulata. International Journal of Advances in Pharmacy Biology and Chemistry, **4**(1).

[9] Kulkarni, S. S., Gokhale, A. V., Bodake, U. M., Pathade, G. R. (2011). Cotton dyeing with natural dye extracted from Pomegranate (Punica granatum) peel. Universal Journal of Environmental Research & Technology **1**(2).

[10] Saha, P. D., Sinha, K. (2012). Natural dye from bixa seeds as a potential alternative to synthetic dyes for use in textile industry. Desalination and Water Treatment, **40**(1-3), 298-301.

[11] Samantaa, A. K., Agarwal, P. (2009). Application on natural dyes on textiles. Indian Journal of Fibre and Textile Research, **34**, 384-399.

[12] Janani, L., Hillary, L., Phillips, K. (2014). Mordanting methods for dyeing cotton fabrics with dye from Albizia Coriaria Plant Species. International Journal of Scientific and Research Publications, **4**(10), 1-6.

[13] Wells, K. (2013). Colour, health and wellbeing: The hidden qualities and properties of natural dyes. Journal of the International Colour Association, 11.

[14] Deshmukh, A. S., Ganeshani, G.. (2013). Kalmkari-An eco-friendly approach for sustainable fashion development. International Journal of Theoretical and Applied Science, **5**(1), 84-87.

[15] Teli, M. D., Valia, S. P., Venkatram, S. (2014). Eco-friendly colouration of vatural Fibre-Pandanus Utilis. Asian Dyers, **11**(1), 24.

[16] Vankar, P. S. (2009). Utilization of temple waste flower-Tagetus erecta for dyeing of cotton, wool and silk on industrial scale. Journal of textile and Apparel Technology and Management, **6**(1).

[17] Zareen, A., Khan, Z., Ajaib, M. (2013). Ethnobotanical evaluation of the shrubs of

Central Punjab, Pakistan. Biologia Pakistan, **59**(1), 139-147.

[18] Ghafoor, A., Aslam, M., Rasool, S. (2012). Determinants of leather goods exports: A case of Pakistan. Journal of Business and Economics, **4**(2), 256-269.

[19] Khalid, B., Inayat, A., Liaquat, L., Yaqub, A. (2008). Application of Lac Dye using different mordants on leather. Physical Sciences, **51**(5), 254-257.

[20] Musa, A. E., Madhan, B., Madhulatha, W., Raghava, Rao, J., Gasmelseed, G. A., Sadulla, S. (2009). Coloring of leather using henna-natural alternative material for dyeing. The journal of the American Leather Chemists Association, **104**(5), 183-190.

[21] Ibrahim S. F., Michael, M. N., Tera F. M., Samaha, S. H. (1997). Optimization of the dyeing process for chemically modified cotton fabrics. Colourage, 27.

[22] Desphande, R., Chaturvedi, A. (2014). Phytochemical screening and antibacterial potential of natural dye, Plumeria rubra (L.). Science Research Reporter, **4**(1), 31-34.

[23] Saha, P., Dutta, S. (2007). Production of floral dyes from different flowers available in west Bengal for textile and dye industry. Retrrieved on 06-23-2016 http://www.chemeca2007.com

[24] Kadolph, J. S., Casselman, D. K. (2004). In the bag: Contact natural dyes. Clothing and Textiles Research Journal, **22**(1-2), 15-21.

[25] Kamel, M. M., Abdelghaffar, F., El-Zawahry, M. M. (2011). Eco-friendly dyeing of wool with a mixture of natural dyes. Journal of Natural Fibers, **8**(4), 289-307.

[26] Saravanan, P., Chadramohan, G., Mariajancyrani, J., Kiruthikajothi, K. (2014). Eco-friendly dyeing of cotton fabric with a natural dye extracted from flowers of Lantana Camara Linn. International Journal of Bioassays, **3**(01), 1653-1656.

[27] Pervaiz, S., Mughal, A. T., Najeebullah, M., Khan, Z. F. (2016). Natural dyes: Extraction of natural dye from *Rosa damascena* Miller: a cost effective approach for leather industry. International Journal of Biosciences, **8**(6), 83-92.

[28] Bhanawat, P. D., Mohta, P. V. (2014). Application of natural dye obtained from Palas on cotton fabric. International Journal for Engineering Applications and Technology, 85-95.

[29] Sundrarajan, M., Gandhi, R. R., Suresh, J., Gowri, S., Selvam, S. (2012). Natural dyeing of silk fabric using eco-friendly mordants. Asian Journal of Chemistry, **24**(7), 3109.

[30] Prabhavathi, R., Devi, A. S., Padma, A. (2015). Improving the acidic perspiration fastness of Eucalyptus bark dye with dye levelling agents on cotton. International Journal of Applied Research, **1**(13), 296-298.

[31] Ohama, P., Tumpat, N. (2014). Textile dyeing with natural dye from Sappan Tree (Caesalpinia sappan Linn.) extract. World Academy of Science, Engineering and Technology. International Journal of Chemical, Molicular, Nuclear, Materials and Metallurgical Engineering, **8**(5), 438-440.

[32] Agarwal, R., Pruthi, N., Singh, S. J. S. (2007). Effect of mordants on printing with Marigold flowers dye. Natural Product Radiance, **6**(4), 306-309.