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Extraction of Ecofriendly Leather Dyes from Plants Bark

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Abstract. Present study is focused on the isolation of ecofriendly dyes from the bark of different plants. Aqueous extracts of the bark of *Mangifera indica* L.*, Syzygium cumini* L. and *Eucalyptus camaldulensis* Dehn were used to dye the crust blue leather of goat. Four different types of mordents $CuSO_4$, $FeSO_4$, $KMnO_4$ and Potash Alum were used. The fastness properties (washing, heating, sunlight and rubbing) were also evaluated by grey scale. *Syzygium cumini* L extract showed more variation in colours. *M. indica* L. showed good fastness properties as compared to others. The formation of light and soft colours with different mordants was observed.

Keywords: ecofriendly, natural dye, leather, mordants, plant bark

Introduction

Synthetic dyes have harmful impact on environment as well as on human beings. These dyes cause many diseases in human beings like liver tumor, kidney and heart damage (Kumar and Sinha, 2004). Therefore natural dyes are gradually replacing the synthetic dyes in the textile industry. Natural dyes are non-toxic, non-carcinogenic and biodegradable in nature. Natural dyes are not only derived from plants but also can be derived from insects like Cochineal and Kerriclacca and can be used for colouring food products (Sundari, 2015; Bhuyan and Saikia, 2008). Shellfish and lichen are also used for the extraction of dyes. Natural dyes derived from plants are ecofriendly and this makes them a priority for use in the textile industry (Bhuyan and Saikia, 2008). All parts of plants like fruit, seed, flowers, wood and bark can be used for the production of dyes. They are used as colouring compound in textile, ink and cosmetics industries (Siva, 2007). Natural dyes show antimicrobial activity and have medicinal applications (Samanta and Agarwal, 2009) and gained economic advantage over synthetic dyes. Kamal *et al*. (2005) described natural dyes extracted by solid- liquid extraction process and applied on cotton and silk. The dyes were extracted from *Terminalia arjuna, Punica granatum* and *Rheum emidi* and applied on cotton and silk. These dyes were developed with enzyme complexes (protease, amylase and lipase) and addition of tannic acid. The samples which were treated with enzymes gave rapid dye adsorption than those which were untreated. Tannic acid enzyme is used as alternative to metal mordents (Vanker *et al*., 2007). Fungal species like *Monascus purpureus, Isaria* spp, *Emericella* spp, *Fusarium* spp and *Penicillium* spp were also used for the extraction of dyes and applied on leather. Different parameters like pH, temperature, colour, brightness, exhaustion of colour, time duration, fastness and colour intensity were used for quality evaluationof dyes. Best results were obtained when pigments were used 6% on leather. Optimized conditions for dyeing were 70 °C, pH, 5 and 120 min (Palanivel *et al*., 2013). But the use of fungal species is difficult to handle because of its rapid growth. The aim of this study was to extract ecofriendly dyes from bark of *Mangifera indica, Syzygium cumini* and *Eucalyptus camaldulensis* and applied on leather. The process for the formation of crust leather from wet- blue leather is also described.

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Materials and Methods

Collection of plant material: After literature survey three different plants *Mangifera indica* L., *Syzygium cumini* L. and *Eucalyptus camaldulensis* Dehn were selected. Plant materials were collected from Lahore College for Women University, Lahore. Voucher specimens were submitted in Herbarium of LCWU for identification of plants.

Extraction of dyes from plants. The plant barks were weighed and washed to remove the dust particles. After washing, barks were cut into small pieces and soaked in water for dye extraction. The ratio of plant material and solvent was 150:800 mL, boiled on water bath approximately for 6-8 h until the final volume of the

extract was 500 mL. Then solution was filtered and stored at 4 °C in the refrigerator for further processing.

Formation of crust leather. The wet-blue leather sample was collected from New Age Tanneries, Lahore for the formation of crust leather described under the following steps:

Wet back. This method was applied to retain moisture and to remove fatty contents of the leather by adding 150% water and 0.5% detergent then rotated in the electric drum (12-15 rpm, 400×200) for 30 min. Moisture retention is necessary for chemical application.

Rechroming of leather. The whole process was done in an electric rotary drum. Rechroming of leather was carried out by adding 150% water v/w and 0.5% formic acid then rotated the drum for 5 min until pH reached at 3.5. After that 6% chrome powder was added and rotated the drum for 1 h. The cut section was checked and added 0.5% sodium formate and rotated the drum for 10 min. Then 0.5% sodium bicarbonate was added and rotated the drum for 1 h, pH at this point was maintained at 4.1-4.2. Chrome (6%) was added for tanning. Finally sodium formate was added to raise the pH a little bit.

Neutralization of leather. This was done to attain an isoelectric point at which pH is 7. Added 150% water, 0.5% sodium formate and 2.0% Taningan PAKS were taken in the drum, rotated it for 30 min. After that 0.5% sodium bicarbonate was added to increase the pH of leather till 7. Again drum was rotated for 45 min. The pH of leather was checked by two liquid indicators, Bromo Cresol Green (BCG) and Bromo Cresol Purple (BCP).

Retaining of leather. The next step was retaining, dyeing and fat liquoring but overall it is called as retanning. In this process 50% water was added at 25 °C, then 2% Yourmer NATE™ was added as acrylic polymer and ledersyn QMF™ as strinmalic and run the reaction for 30 min. Finally two other syntans (5% Tanigan OS and 5% Retanning R7) were added and rotated the drum for further 60 min.

Fat liquoring of leather. The last step was fat liquoring of leather. It was done for the softening of leather. Softening and lubrication are carried out to increase leather shelf life. In this procedure 7% Plentol (BA) and 7% Sultosol (SK_3) were added and set the rotary for 60 min. Then 100% water was added at 70 °C. Later on 3.0% formic acid in the ratio of 1:10/1:20 (for this 1g formic acid mixed in 20 mL distilled water) was added. Formic acid was added gradually in intervals of 10,10 and 25 min for the fixation of pH.

Dyeing of leather. For dying of leather 50g piece of crust leather was placed in the rotary drum containing 150 mL of aqueous dye and run the drum for 30 min. Formic acid was then slowly added in the aqueous dye after 10-25 min for the fixation of dye at pH 3.5. Four mordents like $CuSO_4$, $KMnO_4$, $FeSO_4$ and Pot. Alum were used for fixation and to improve the colour of the leather. 0.5g mordant was added in the drum to fix the dye and run the drum for 30 min. The extract was drained and the leather strip was rinsed and dried and the colour was checked.

Fastness properties of dye. Fastness properties of dye were checked by different parameters like transfer of colour from leather to cotton, change in colour by sunlight, heating, washing and rubbing. These properties were checked with the help of grey scale reading. The grey scale ranges from 1-5.

Washing. Transfer of colour from leather to the cotton fabric was checked by washing technique using soap solution.

Preparation of soap solution. Soap solution was prepared by dissolving 5g soap in 1 liter water in a flask having magnetic stirrer and put on hot plate for 30 min. Magnetic stirrer was used for complete dispersion and to prevent the settling of soap. The ratio of specimen and soap solution used was 1g of specimen and 50mL of soap solution. A piece of cotton binded with dyed specimen of leather, then dipped in beaker having soap solution and stirred continuously under specific condition (45 °C) for 45 min. The leather was then washed to check any change and migration of colour on cotton by comparing with the original leather and cotton. The fastness property of colour was evaluated with the help of grey scale.

Rubbing. Rubbing was checked by following two techniques.

Dry rubbing. Dry rubbing of leather was carried out with the help of instrument FELT under pressure with to and fro movement on standard cloth. After 15min invert the felt and the colour migration from leather to standard cloth was checked. The fastness of colour was than evaluated with the help of grey scale.

Wet rubbing: The wet rubbing was also done under the same conditions as dry rubbing except that the

standard rubbing cloth was soaked into 100% de-ionized water.

Sunlight. For this purpose a half covered wooden box was taken, specimens was kept in the box and placed it in sunlight for 24 h. The portion of leather which was exposed to sunlight was compared with the covered portion and the colour variation and fastness property of colour was evaluated with the help of grey scale.

Heating. The specimen was heated with the iron and compared its colour with the original colour .The fastness property of colour was evaluated with help of grey scale.

Results and Discussion

Synthetic dyes are widely used not only for the dyeing of leather but wool, cotton and silk too. They are not ecofriendly and show environmental hazards. European Union banned the use of azo dyes because of its harmful effects (Saravanan *et al*., 2013; Sivakumar *et al*., 2011). To overcome hazards of synthetic dyes plants extracts are used for dyeing purpose. Plants dyes are eco-friendly (Purwar, 2016; Bechtold and Mussak, 2009). The present study is concerned with dyeing of leather by using the extracts of plants *M. indica*, *S. cumini* and *E. camaldulensis* for dyeing purpose. The barks of these plants were selected for extraction of dye (Fig. 1). Four different types of mordants ($CuSO_4$, $KMnO_4$, $FeSO_4$ and Pot- Alum) were used for the fixation of dye. The

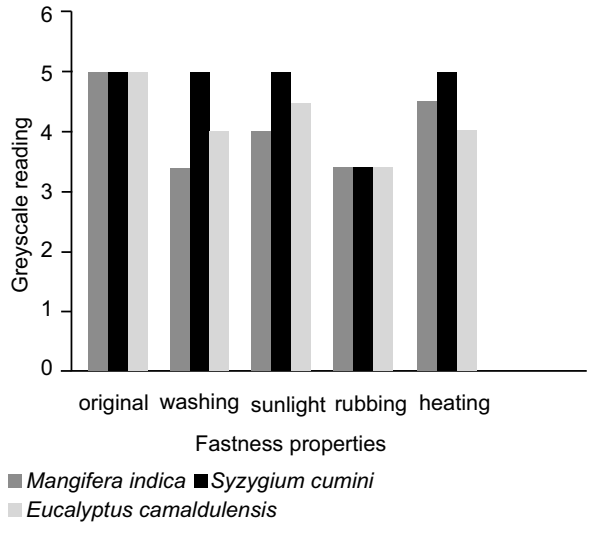

Fig.1. Fastness properties of *E.camaldulensis*, *S.cumini* and *M. indica* without mordant.

colour of extract of *E. camaldulensis* bark was brown. It gave four different colours with the four mordants. $CuSO_4$ gave chocolate brown colour, $FeSO_4$ gave dark blue shade, $KMnO_4$ gave dark brown and Pot. Alum gave greyish brown colour (Table 1). Its fastness properties after washing ranged between 3/4 to 4/5, a sunlight range between 4 to 5, rubbing ranged between

Table 1. Colour variation of leather dyed with aqueous extract *E. Camaldulensis S.cumini and M. indica*

Plant materials	Mordants	Leather colours
Eucalyptus camaldulensis	No mordant	
	$CuSO_4$	
	$FeSO_4$	
	$KMnO_4$	
	$KAl(SO_4)_2$	
Syzygium cumini	No mordant	
	$CuSO_4$	
	$FeSO_4$	
	$KMnO_4$	
	$KAl(SO_4)_2$	
Magnifera indica	No mordant	
	$CuSO_4$	
	$FeSO_4$	
	$KMnO_4$	
	$KAl(SO_4)_2$	

3/4 to 4 and after heating 4/5 to 5 in greyscale reading. (Fig. 2-5)

The colour of *S. cumini* extract was brown. By using mordents different colours were obtained. $CuSO_4$ gave brown colour, $FeSO_4$ gave blue colour, with $KMnO_4$ dark brown was obtaind and Pot. Alum gave light brown colours (Table 1). Its fastness properties after washing ranged between 3/4 to 4/5, sunlight ranged between 4 to 5, rubbing range between3/4 to 4 and heating showed 4/5 to 5 in grey scale reading.(Fig. 3)

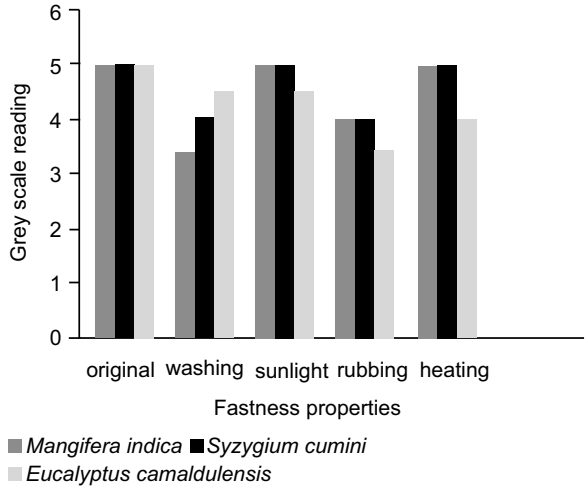

Fig. 2. Fastness properties of *M.indica*, *S. cumini* and *E. camaldulensis* with $CuSO_4$ mordant.

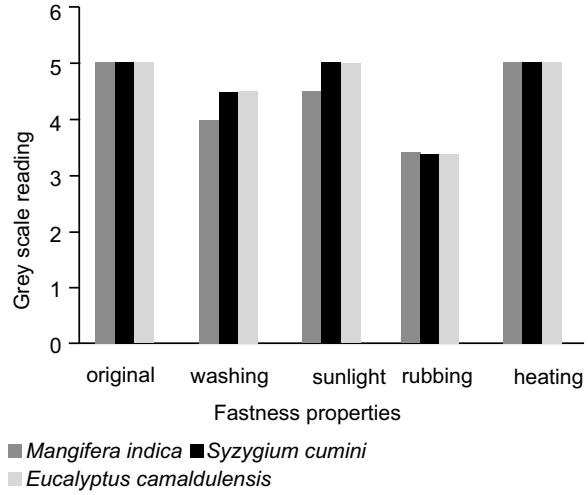

Fig. 3. Fastness properties of *M.indica*, *S. cumini* & *E. camaldulensis* with $FeSO_4$ mordant.

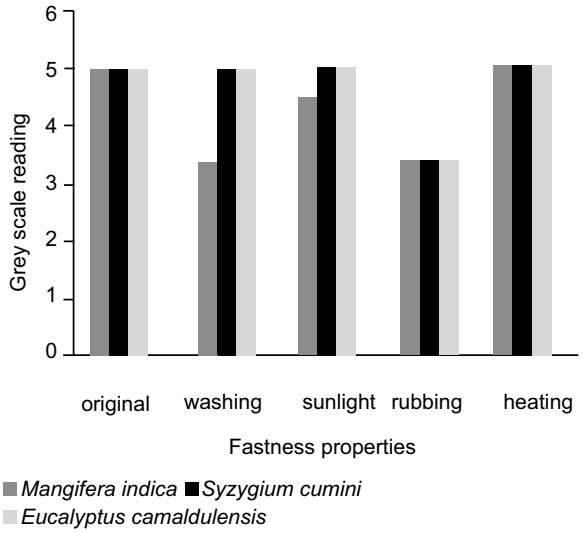

Fig. 4. Fastness properties of *M.indica*, *S. cumini* and *E. camaldulensis* with $KMnO_4$ mordant

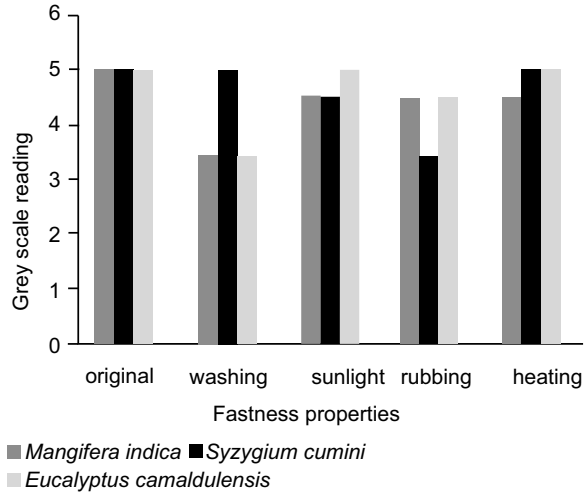

Fig. 5. Fastness properties of *M.indica*, *S. cumini* and *E. camaldulensis* with Pot. alum mordant.

Original colour of *M. indica* extract was brown and $CuSO_4$ mordant gave dark brown, $FeSO_4$ gave black, $KMnO_4$ and Potash Alum gave light brown colours (Table 1). Its fastness properties ranged between good and excellent. After washing ranged between3/4 to 4/5, sunlight ranged between 4 to 5, after rubbing ranged between 3/4 to 4 and after heating 4/5 to 5 in grey scale reading (Fig. 2-5). Selvi *et al*. (2013) used seeds of *Bixa orellana* for the extraction of dye colour and applied on leather for finishing and dyeing. In the present study

barks of *M. indica*, *S. cumini* and *E. camaldulensis* were used which are mostly wasted part of the plant so this work is low in cost than the previous work. The leaves of *Acalypha indica* Linn were also used for the extraction of dyes by post-mordating technique. In the present study metamordating technique is used which is more convenient.

Conclusion

This study conclude that natural dyes extracted from *M.indica*, *S. cumini* and *E. camaldulensis* can be successfully applied on leather and different shades can produced from the same extract by using different mordants. These dyes are ecofriendly and excellent alternate of synthetic dyes.

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