COMPARATIVE STUDIES OF COLOUR FASTNESS PROPERTIES OF GOAT LEATHER DYED WITH *ROSA DAMASCENA* AND *PAPAVER RHOEAS* FLOWERS

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ABSTRACT: *Colour fastness of naturally dyed substrates is very important from industrial point of view. Therefore, the present study was carried out to extract environment friendly natural dyes from Papaver rhoeas and R. damascena flowers using aqueous method. The aim of the present study was to study the colour fastness properties of R. damascena and P. rhoeas dye. The colour fastness properties viz. rubbing, mild washing and daylight were evaluated and compared with and without mordants. On the basis of results, twenty two exclusive shades were procured with and without mordants. Results of the study demonstrated very good to excellent response was obtained in rubbing and mild washing with R. damascena dye. Moreover, good to very good results in rubbing and mild washing were recorded with P. rhoeas dye whereas colour fastness to daylight rendered moderate results. From the comparative analysis of results, it was concluded that R. damascena dye gave better results as compared to the P. rhoeas dye in colour fastness properties of dyed leather specimens.*

Keywords: Colour fastness, goat leather, natural dye, *Papaver rhoeas*, *Rosa damascena*

INTRODUCTION

Leather industry is one of the major consumer of azo dyes [1] which are known to be carcinogenic and hazardous [2, 3]. Owing to mutagenic, teratogenic impacts of azo dyes and the strict environmental standards, ban is imposed on their use [4, 5, 6, 7] which recapture the consumer's demand towards green natural, eco-safe products [8] worldwide.

Almost all plant parts are used for dye extraction. Similarly, several studies are reported on application of natural dyes for leather dyeing such as marigold [9, 10], beetroot [11], henna leaves [12], eucalyptus bark [13], walnut bark, turmeric rhizomes, tea leaves and *Rubia tinctorum* plant roots [14], *Bixa orellana* seeds [15], kola nut and henna [16], *Justicia carner hooker* stem [17], *Mucuna pruriens* [18], *Celosia cristata, Lantana camara* and *Rosa damascena* [10].

On the other hand, for the commercialization of natural dyes, colour fastness is the most important aspect of dye durability. Therefore, keeping in view the current demand of environmentally friendly dyes, the present study was carried out to extract dye from *P. rhoeas* and *R. damascena* flowers and study its application on goat leather. In the present work, an attempt has been made to evaluate the colour fastness of dyed leather specimens too *i.e.* rubbing (dry & wet), mild washing and daylight [19].

MATERIALS AND METHODS

Materials

Flowers

P. rhoeas and *R. damascena* waste flowers were collected from the Jinnah Garden, Lahore, Pakistan.

Leather

The chrome tanned goat crust leather was procured from the District Sialkot, Punjab.

Chemicals

Commercial grade mordants and chemicals such as acetic acid, aluminium sulphate, copper acetate, copper chloride, copper sulphate, ferric chloride, ferrous sulphate, formic acid, potash alum, potassium dichromate, sodium bicarbonate, sodium formate, sodium hydroxide and tartaric acid were purchased from local market.

Methods

Dye extraction

P. rhoeas and R. damascena waste flowers were collected, weighed and washed thoroughly with tap water [1, 10, 20].

Environment friendly, conventional aqueous dye extraction procedure was adopted [1, 21]. 50 g of flower petals were immersed in 500 mL distilled water at ambient temperature for 36 hours. Then, soaked flower petals were heated gently at 40˚C for 40 minutes to get the maximum dye extraction and left for cooling. The solution was then filtered using Wattman filter paper No.1 [1].

Leather dyeing & mordanting

The leather was soaked for one night and then treated with the 1% solution of sodium bicarbonate and sodium formate in micro steel drum for 30 minutes. After this, leather was washed with tap water thoroughly [1, 10, 20].

Pre-mordanting method was selected for treating goat crust leather with ten mordants. 1 M solution of each mordant was used for mordanting for 60 minutes. After mordanting, the samples were dyed with dye extract immediately [1, 10, 20].

Drum dyeing technique [22] was used to dye leather. For this, the leather specimens were dyed in two installments. In first installment, the goat crust leather was dyed with 250 mL liquid extract for 30 minutes. Then, pH of the liquid extract was adjusted at 3.0 by adding fixing agent (formic acid) and further dyed for 30 minutes. In second installment, the same process was repeated [1, 10, 20].

Drying

After dyeing, the leather specimens were hanged in open air for drying.

Determination of Colourfastness Properties

All the dyed leather specimens were evaluated in terms of colour fastness to rubbing (BS 1006:1990); mild washing (ISO 15703:1998) and daylight (ISO 105-B01:1999).

RESULTS AND DISCUSSION

Visual assessment of dyed leather

The visual appearance of dyed leather specimens exhibited good variety of shades with *P. rhoeas and R. damacena*. Moreover, good levelness and depth of shades was obtained by adopting dyeing using different mordants [1, 2].

Dye penetration

The dye penetration level was observed at fair level with and without mordants using *R. damascena* dye. The present study results showed close conformity with the findings of [1] and [23]. In addition to this, very good dye penetration was observed with *P. rhoeas* dye with and without mordants.

Shades obtained from *P. rhoeas* and *R. damascena* dye with and without mordants

Analyzing Table 1, it was noticed that the application of mordants produced 20 varieties of shades. In the previous study of Musa *et al*. [23] leather dyed with henna extract also reported that variety of shades were obtained with different mordants. It was observed from Table 1 that pinkish blue and light pink shades were developed with *P. rhoeas* dye using potash alum and copper sulphate. Potassium dichromate produced yellowish shade. Application of aluminium sulphate and acetic acid modants exhibited blue shade. Dark biscuit shade is the dominant shade developed with ferric chloride mordant. Sand grey shade was obtained with copper acetate mordant while light grey shade noted with copper chloride mordant.

Observing *R. damascena* shades, it was also noticed that all the produced shades were dark in colour except with potash alum. Potash alum produced greenish yellow shade. Beautiful beige shade was developed with potassium dichromate.

Table 1. Shades Obtained with *P. rhoeas and R. damascena* Dyes

	P. rhoeas	*R. damascena*
Without Mordant		
Acetic Acid		
Aluminium sulphate		
Copper acetate		
Copper chloride		
Copper sulphate		
Ferric chloride		
Ferrous sulphate		
Potash alum		
Potassium dichromate		
Tartaric Acid		

Mordants effects

Strong colour fastness of natural dye is mordant dependent which plays key role to chelate good bonding with dye molecules [1, 26, 27, 28]. In the present studies, it was observed that best co-ordination of dye was obtained with *R. damascena* dye in ferrous sulphate and ferric chloride mordants.

Colour fastness to rubbing

Results of rubbing (dry and wet) with *P. rhoeas* and *R. damascena* dyes are presented in Table 2. On analyzing results, it was noticed that very good staining results were observed in dry state with and without mordants. Moreover, very good staining results in wet state were found with acetic acid, aluminium sulphate, copper acetate, copper chloride, copper sulphate, potash alum, potassium dichromate and without mordant. While ferrous sulphate and ferric chloride rendered good staining results in wet rubbing. Observing change in colour results in dry state, it was revealed that excellent grade (5) was obtained with potash alum whereas rest of the mordants gave very good results including without mordant. Further analyzing change in colour in wet state, very good results obtained with and without mordants.

Furthermore, it was evident from the results that excellent staining (5) results were obtained in dry state with and without mordants using *P. rhoeas* dye. Assessing results of staining in wet state, it was revealed that very good staining (4-5) results were obtained with aluminium sulphate, copper acetate, copper chloride, copper sulphate, ferric chloride, ferrous sulphate, potash alum and tartaric acid. While un-mordanted dyed leather specimen also noted with very good staining results (4-5) in wet state. In case of change in colour results, it was found that very good results (4-5) in dry state were developed with copper acetate, copper chloride, ferric chloride, ferrous sulphate, potash alum and potassium dichromate. Meanwhile good change in colour (3-4) was observed with acetic acid, aluminium sulphate and copper sulphate mordants. Observing change in colour results in wet state, it was analyzed that very good results (4) were obtained with ferric chloride and potassium dichromate mordants. Good change in colour results were noted with acetic acid, copper acetate, copper chloride and ferrous sulphate mordants. While very poor results (1) of change in colour in wet state were observed with aluminium sulphate, copper sulphate, potash alum and tartaric acid mordants. Findings of the results demonstrated that *R. damascena* dye showed good to very good rub fastness results as compared to *P. rhoeas* dye.

Copper sulphate exhibited peer green reported shade [24]. Olive green shade was developed with aluminium sulphate mordanted specimen. The ferrous sulphate mordanted specimens were found in greyish black shade which is similarly reported on cotton by Patil *et al*. [25]. Ferric chloride mordant also produced dark greyish black shade. Moreover, copper acetate mordanted specimen was found in greenish yellow tone. Acetic acid and tartaric acid mordanted speciemns were found in the brownish shade.

Table 2. Colour Fastness to Rubbing with *P. rhoeas* and *R. damascena* Dyes

Mordants/ Without mordant	*P. rhoeas*				*R. damascena*			
	Staining		Change in Colour		Staining		Change in Colour	
	(Dry)	(Wet)	(Dry)	(Wet)	(Dry)	(Wet)	(Dry)	(Wet)
Without mordant	5	4-5	3-4	1	4	4	4-5	4-5
Acetic acid	5	3-4	3-4	3	4-5	4	4-5	4-5
Aluminium sulphate	5	4	3-4	1	4	4-5	4-5	4-5
Copper acetate	5	4	4	3-4	4-5	4	4	4
Copper chloride	5	4-5	4	3-4	4-5	4	4-5	4
Copper sulphate	5	4	3-4	1	4-5	4-5	4-5	4-5
Ferric chloride	5	4	4	4	4	3-4	4	4
Ferrous sulphate	5	4	4	3-4	4	3-4	4	4
Potash alum	5	4	4	1	4-5	4-5	5	4-5
Potassium dichromate	5	3-4	4	4	4-5	4	4-5	4-5
Tartaric acid	5	4	3	1	4-5	4-5	4-5	4-5

Where:5= Excellent, 4= Good, 3= Average, 2= Poor, 1= Very Poor

Colour fastness to mild washing

The dyed leather specimens were assessed on the basis of staining on the multifiber and change in color of the specimen using grey scale. Colour fastness to washing results have been shown in Table 3. *P. rhoeas* dye showed excellent staining results (5) on acetate with and without mordants. Excellent staining results (5) on cotton, nylon, polyester and acrylic were found with acetic acid, aluminum sulphate, copper acetate, copper chloride, copper sulphate, ferric chloride, ferrous sulphate, potash alum, potassium dichromate and tartaric acid mordants. On wool, very good staining results (4-5) were obtained with all selected mordants. Analyzing results of mild washing, it was found that very good change in colour ratings (4-5) were obtained with copper sulphate and ferric chloride mordant. Good results of change in colour were observed with acetic acid, aluminium sulphate, copper acetate and copper chloride mordants. On the other hand, analyzing results of change in colour with copper sulphate, ferrous sulphate, potash alum and tartaric acid mordant, poor change in colour results (1) were noted. Moreover, with *R. damascena* dye, excellent staining grade (5) was observed on acetate with and without mordants except tartic acid which was recorded with staining grade (4-5). Excellent staining on cotton was evaluated with acetic acid copper chloride, potash alum, potassium dichromate and without mordant. Moreover very good staining grades on cotton were observed with aluminium sulphate, copper acetate, copper sulphate, ferrous sulphate and tartaric acid mordants. Analyzing staining results on nylon, it was found that excellent grade was observed with copper chloride and without mordant whereas rest of the mordants rendered very good grades (4-5). In addition, excellent results were obtained on polyester and acrylic with and without mordants except aluminium sulphate which presented very good rating (4-5). Results of staining on wool depicted excellent rating with acetic acid, copper acetate, copper chloride, ferric chloride, ferrous sulphate, potash alum and tartaric acid mordants whereas rest of the mordants rendered good results. Moreover, very good change in colour results were obtained with and without mordants.

Table 3. Colour Fastness to Mild Washing with *P. rohes and R. damascena* Dyes

Mordants/ Without mordant	*P. rhoeas*							*R. damascena*						
	Staining						Change in Colour	Staining						Change in Colour
	CA	CO	PA	PES	PAN	WO		CA	CO	PA	PES	PAN	WO	
Without Mordant	5	5	4-5	4-5	5	4-5	1	5	5	5	5	5	5	4-5
Acetic acid	5	5	5	5	5	4-5	3	5	5	4-5	5	5	5	5
Aluminium sulphate	5	5	5	5	5	4-5	3	5	4-5	4-5	4-5	5	5	4-5
Copper acetate	5	5	5	5	5	4-5	3-4	5	4-5	4-5	5	5	5	5
Copper chloride	5	5	5	5	5	5	3	5	4-5	5	5	5	5	5
Copper sulphate	5	5	5	5	5	4-5	1	5	4	4-5	5	5	5	4-5
Ferric chloride	5	5	5	5	5	4-5	4-5	5	5	4-5	5	5	5	5
Ferrous sulphate	5	5	5	5	5	4-5	1	5	4-5	4-5	5	5	5	5
Potash alum	5	5	5	5	5	4-5	1	5	5	4-5	5	5	5	5
Potassium dichromate	5	5	5	5	5	4-5	4-5	5	5	4-5	5	5	5	4-5
Tartaric acid	5	5	5	5	5	4-5	4-5	4-5	4	4-5	5	5	5	5

Where: CA=Acetate, CO= Cotton , PA= Nylon, PES= Polyester, PAN= Acrylic, WO= Wool
5= Excellent, 4= Good, 3= Average, 2= Poor, 1= Very Poor

Colour fastness to daylight

Light is important factor which effects the dye durability. Therefore, obtained dyed specimens were assessed for the sunlight exposure. Results of colour fastness to daylight with *P. rhoeas* dye produced very good change in colour grade (6) with ferric chloride mordant. Moderate grade (3) was obtained with potassium dichromate whereas acetic acid, aluminium sulphate, copper chloride, copper sulphate, potash alum and tartaric acid were exhibited poor change in colour grades which showed that *P. rhoeas* dye is not colour fast to daylight. Furthermore, the unmordanted leather specimen results similarly confirmed the findings on cotton Gedik *et al*. [29] who reported the similar unsatisfactory result of dye colour fastness to daylight.

Results of colour fastness to daylight with *R. damascena* dye were observed moderate to very good (Table 4). Very good change in colour (4) was obtained with copper chloride mordant. Application of ferric chloride and ferrous sulphate mordants also produced good change in colour results. Moderate results of change in colour were obtained with tartaric acid which is acceptable level of daylight fastness. Potassium dichromate and potash alum gave poor colour change results. Moderate to good daylight fastness grades on cotton were also reported with rose petals dye [24].

Table 4. Colour Fastness to Daylight with *P. rohes and R. damascena* Dyes

Mordants/ Without Mordant	*P. rhoeas*	*R. damascena*
	Change in colour according to blue wool scale	Change in colour according to blue wool scale
Without Mordant	2	2
Acetic acid	2	3
Aluminium sulphate	2	3
Copper acetate	2	3
Copper chloride	2	4
Copper sulphate	2	3
Ferric chloride	6	3
Ferrous sulphate	2	3
Potash alum	2	2
Potassium dichromate	3	2
Tartaric acid	2	3

Where: 8= Exceptional, 7= Excellent, 6= Very Good, 5= Good, 4= Fairly Good, 3= Average, 2= Poor, 1= Very Poor

CONCLUSION

Flowers can serve as a major source of eco- friendly dyeing agents and have great potential of non-toxic colourant for dyeing leather. Results of the study revealed that a good variety of twenty-two splendid shades were obtained with and without mordants. Moreover, it was concluded from the comparative analysis of colourfastness results that *R. damascena* dye is well suited for leather dyeing. In addition, it was also notable that fragrant dyed leather specimens were obtained with *R. damascena* dye.

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