Research Article

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Dyeing of Silk with Eco-Friendly Natural Dyes obtained from the Flower of *Russelia equisetiformis* using Single Mordants

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ABSTRACT

In this present research work, the Natural dyes recovered from the flower of Russelia equisetiformis were used to dye the silk fabric sample. The coloured silk materials' fastness and its strength were studied. According to the results of a comparative analysis of the dyed silk samples' fastness and colour strength, the Russelia equisetiformis yields better results in a different mordanting process using a three percent mordant combination.

Keywords: Colour strength; fastness; mordant; natural dye; *Russelia equisetiformi*.

1. INTRODUCTION

The current situation emphasises the use of the vast variety of natural colour pigment resources for use in food ingredients, pharmaceuticals, and textiles over their manufactured counterparts. The goal of this trend is to preserve and extend human well-being as well as life on the planet.

Because of the increased understanding of environmental concerns, as well as the toxicity caused by synthetic dyes, natural colourants have gained popularity for dyeing textile fibres due to their improved biodegradability and compatibility. The aim of this study is to extract an eco-friendly natural dye from the *Russelia equisetiformis* flower and apply it to silk fabrics using single mordant. Using various concentrations of *Russelia equisetiformis* flower dyed silk fabrics, the fastness properties were investigated (1%, 2% and 3%). Brush, rub, shine, and perspiration fastness were tested on the dyed samples.

However, due to strict environmental requirements introduced by many countries in response to harmful and allergic reactions associated with synthetic dyes, interest in the use of natural dyes has recently risen rapidly (Anderson, 1971; Samanta *et al.*. 2007; Sandeep Bains *et al.* 2005).

As a result of the new environmental consciousness, the focus of the researcher has turned to the use of natural dyes for dyeing textile fabrics (Sandeep Bains, 2003).

2. MATERIALS AND METHODS

In this present study the Author focus on the synthesis of natural dye from the *Russelia equisetiformis* vine. This work was conducted on bleached silk cloth at Gandhi gram Rural University in Dindugal.

Fig. 1: Flower of *Russelia equisetiformis*

Analytical reagents include ferrous sulphate, aluminium sulphate, nickel sulphate, potassium dichromate, stannous chloride, commercial-grade acetic acid, general salt, and sodium carbonate (AR). The study used a natural mordant myrobolan (*Terminalia chebula*) powder (Kumaresan *et al.* 2011; 2012a). To

obtain a brown colour part for fabric dyeing, an ethanol extract of the flower of *Russelia equisetiformis* was used. The colour of *the Russelia equisetiformis* flower extract on textiles varies depending on the mordant used.

The flower of *Russelia equisetiformis* was dried, powdered, and submerged in warm water overnight. The colour extract was made by heating it in the same water as the colour extract. After cooling, the dye extract was purified and used for dyeing. Dye extraction time was 60 minutes, material-to-liquor ratio was 1:20, temperature was 60 degrees Celsius, wavelength was 420 nm, and dyeing time was 55 minutes.

Myrobolan: nickel sulphate, myrobolan: aluminium sulphate, myrobolan: potassium dichromate, myrobolan: ferrous sulphate, and myrobolan: stannous chloride were used in 1 percent, 2 percent, and 3 percent concentrations, respectively. In each mixture, the overall volume of two mordants used was 5% owf, or 5 g of mordant per 100 g of cloth. For each of the five mordant variations, all three mordanting processes, namely pre-mordanting, simultaneous mordanting, and post-mordanting for dyeing, were used in three different ratios.

The dyed fabric samples' colour fastness to washing[2] was calculated using a Samira launder-O-meter and the IS: 764 – 1984 wash fastness process. The wash fastness rating was calculated using greyscale in accordance with ISO-05-A02 (loss of shade depth) and ISO-105-AO3 (extent of staining), and the results were double-checked using a Macbeth 2020 plus computer-aided colour measurement system and related tools to calculate colour loss and staining. A manually controlled crock metre and greyscale were used to test colour fastness to rubbing (dry and wet) according to ISO-105-AO3 (extent of staining).

The IS: 2454-1984 approach was used to assess colour fastness to light exposure. The material was exposed to UV light in a Shirley MBTF Microsal fade-O-meter (with a 500 watt Philips mercury bulb tungsten filament lamp simulating daylight) in addition to the eight blue wool requirements (BS1006: BOI: 1978). The fading of each sample was compared to blue wool norms.

According to IS 971-1983, the colour fastness to perspiration was tested, and a hybrid specimen was created by sandwiching the test specimen between two adjacent pieces of silk and stitching all four sides together. Separately, the sample was immersed for 30 minutes at room temperature in the test solution (acidic/alkaline) with MLR 1:50. After that, the sample was placed between two perspirometer glass plates and subjected to a 4.5kg load (10 lbs). At 372 degrees Fahrenheit, the equipment was kept in the oven for 4 hours. The specimen was removed at the end of this period and dried in the air at a temperature of no more than 60°C. Grey scales were used to grade the research samples for colour shift and staining.

On all mordant combinations, all treated samples exposed to light exhibit very strong light fastness. Many of the processed samples have wash fastness ratings of 3 to 4, and no colour staining has been found.

Many of the processed samples showed outstanding colour change upon dry and wet rubbing. In dry rubbing, there is a range of colour staining from none to hardly visible. In both acidic and alkaline media, the majority of the treated samples exhibit outstanding colour fastness grades. In both acidic and alkaline media, there is no colour staining on any of the treated samples (Table 1). Three separate mordant combinations, such as 1%, 2%, and 3%, were prepared for this analysis by combining the natural mordant myrobolan with five inorganic mordant and dyed on silk fabrics. Table 2, 3, 4 and 5 show the colour fastness and colour intensity values of dyed silk fabrics obtained in this analysis using different combinations of mordants, as well as the values obtained by previous researchers. The mordant ferrous sulphate and aluminium sulphate produced excellent results in all three methods of dyeing using three plant sections.

The analysis of colour intensity results shows that the 3 percent mordant combination is the best for dyeing of the three mordant combinations. When comparing the three dyeing processes, the simultaneous process produced excellent results in both natural dyes.

Mahajan *et al.* (2005) published a previous analysis that yielded similar findings. According to the data in Table 4, the greater the concentration of mordants, the higher the value of K/S would be (Pan *et al.* 2003). When $SnCl_2$ (GS : 2) as a mordant in the pre mordanting process, the lightfastness (GS : 4-5) was better in the current study than our previous work using same mordant (Kumaresan, 2015).

Table 1. Surface colour strength of chosen dyed silk fabric after pre, simultaneous and post mordanting methods by using 1% mordant concentration (K/S value without mordant: silk-1.29)

Mordant concentration	K/S(λ =420 nm)		
	Pre mordanting	Simultaneous mordant	Post mordant
$NiSO_4$	1.22	2.34	2.01
$Al_2(SO_4)_3$	1.60	2.44	2.48
$K_2Cr_2O_7$	1.14	1.19	1.15
$FeSO_4$	1.65	2.56	2.56
$SnCl_2$	1.40	2.41	2.22
Myrobolan	0.91	1.20	1.26

Table 2. Surface colour strength of flowe4xr of *Russelia equisetiformis* dyed silk fabric after pre, simultaneous and post mordanting methods by using 1% mordant concentration (K/S value without mordant: silk-1.29)

Mordant concentration	K/S(λ =420 nm)		
	Pre mordanting	Simultaneous mordanting	Post mordanting
$NiSO_4$	1.22	2.34	2.01
$Al_2(SO_4)_3$	1.60	2.44	2.48
$K_2Cr_2O_7$	1.14	1.19	1.15
$FeSO_4$	1.65	2.56	2.56
$SnCl_2$	1.40	2.41	2.22
Myrobolan	0.91	1.20	1.26

Table 3. Surface colour strength of flower of *Russelia equisetiformis* dyed cotton fabric after pre, simultaneous and post mordanting methods by using 2% mordant concentration (K/S value without mordant: silk-1.29)

Mordant concentration	K/S(λ =420 nm)		
	Pre mordanting	Simultaneous mordanting	Post mordanting
$NiSO_4$	1.22	2.40	2.06
$Al_2(SO_4)_3$	1.67	2.54	2.56
$K_2Cr_2O_7$	1.21	1.29	1.24
$FeSO_4$	1.78	2.74	2.65
$SnCl_2$	1.41	2.49	2.30
Myrobolan	1.01	1.30	1.28

Table 4. Surface colour strength of flower of *Russelia equisetiformis* dyed cotton fabric after pre, simultaneous and post mordanting methods by using 3% mordant concentration (K/S value without mordant: silk-1.29)

Mordant concentration	K/S(λ =420 nm)		
	Pre mordanting	Simultaneous mordanting	Post mordanting
$NiSO_4$	1.21	2.38	2.04
$Al_2(SO_4)_3$	1.64	2.51	2.51
$K_2Cr_2O_7$	1.20	1.25	1.20
$FeSO_4$	1.71	2.65	2.59
$SnCl_2$	1.42	2.46	2.26
Myrobolan	1.01	1.29	1.30

Table 5. Comparison of fastness properties of dyed cotton using single mordants

Plant parts used for dyeing	Mordant used	Method	Properties						Reference
			WF	LF	RF		PF		
					Dry	Wet	Acidic	Alkaline	
Flower of *Russelia equisetiformis*	$FeSO_4$ (3%)	SM	4-5	4	5	5	5	4	Present Study
		PM	5	7	5	5	5	**4**	
	$Al_2(SO_4)_3$ (3%)	SM	4-5	5	4	4-5	5	4-5	
		PM	4-5	6	**4**	5	4	4	
Stem of *Achras sapota*	$FeSO_4$ (3%)	SM	5	4	5	5	5	5	Kumaresan *et al.* 2016
		PM	5	4	5	5	5	5	
	$Al_2(SO_4)_3$ (3%)	SM	4-5	4	5	5	5	5	
		PM	5	4	5	5	4	4	
Flower of *Cordia sebestena*	$FeSO_4$ (3%)	SM	5	5	5	5	5	5	Kumaresan *et al.* 2017
		PM	5	5	5	5	5	5	
	$Al_2(SO_4)_3$ (3%)	SM	4	5	5	4	4	4	
		PM	5	4	5	5	5	5	
Onosma echioides	$FeSO_4$ (3%)	SM	5	2	5	5	4	5	Sandeep Bains *et al.* 2003
	$Al_2(SO_4)_3$ (5%)	SM	5	2	4	3-4	5	5	
Fountain flower	$FeSO_4$ (3%)	SM	4-5	5	4-5	4	4-5	4-5	Shilpa Mudgal and Geeta Mahale, 2002
Mangifera indica	$FeSO_4$ (2.5%)	SM	5	4	4-5	4	5	5	Sandeep Bains *et al.* 2003
	$Al_2(SO_4)_3$ (12.5%)	SM	5	4	4-5	4	5	5	
Colquhounia coccinea	$FeSO_4$ (2.5%)	PM	4-5	4-5	5	5	5	5	Vankar *et al.* 2010
	$Al_2(SO_4)_3$ (12.5%)	PM	4	4	4	4	4	4	
Pongamia pinnato	$FeSO_4$ (2.5%)	SM	-	5	4-5	4-5	-	-	Kumar *et al.* 2004
	$Al_2(SO_4)_3$ (12.5%)	SM	-	5	4-5	4-5	-	-	
Neem tree bark	$Al_2(SO_4)_3$ (12.5%)	PM	3	2-3	4-5	4-5	-	-	Boonroeng *et al.* 2009

WF-Wash fastness; LF-Light fastness; PF-Perspiration fastness; RF-Rub fastness; CS-Colour strength; PM-Pre mordanting; SM-Simultaneous mordanting.

Similar results were obtained in the previous study reported by Das *et al.* (2008). The present study shows excellent wash fastness (GS : 5) and lightfastness (GS :5) when compared with Vankar *et al.* (2010). A better lightfastness (GS : 7) was reported in the present study in simultaneous mordanting method.

4. CONCLUSION

The flower of *Russelia equisetiformis* was discovered during a comparative analysis of fastness properties and colour power of dyed cotton samples. The use of a 3 percent mordant mixture in a simultaneous mordanting process produces stronger results.

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