

An Eco-Friendly Dyeing of Woollen Fabric by *Sida Cordifolia* Natural Dye

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Abstract

Since the ancient times human beings have been using herbs and plants for curing of various diseases, wound healing, etc. as these were easily available and abundant in nature. With the advancement in technology these herbs have been used in pharmaceutical industries for making of drugs using their chemical compositions and properties. These herbs have a great potential for wound curing, healing and giving a healthy life. *Sida-cordifolia* is also such type of herb having origin in tropical and subtropical places. This herb has been well mentioned in ayurveda but rare or no literature available regarding its colouring behaviour. So, present study has been carried out to explore its colouration behavior on woollen textile material. The dye powder was obtained using aqueous extraction method and applied via three methods of mordanting i.e. pre-mordanting, meta-mordanting and post-mordanting with different natural and chemical mordants. The colour values (L, a and b) and various colour fastness properties of dyed samples were evaluated. The finding of the research shows that woollen fabric dyed with *Sida-cordifolia* with various mordant have colour coordinates in green-yellow region with satisfactory wash, light and rubbing fastness properties.

Keywords: *Sida Cordifolia*, Natural Dye, Wool, Natural and Synthetic Mordant.

Introduction

Natural dyes have been in use since Vedic era but due to poor shades and fastness properties synthetic dyes have replaced most of these dyes in industrial market. Beside these, synthetic dyes also produced at large scale at lower costs. Although now a days people are more concerned about the environment and focusing on biodegradability and eco-friendly processes. Natural dyes seem good eco-friendly alternative to synthetic dyes, but an increase in population has restricted the recourses and land for renewable natural dyes. Although natural dyes especially based on natural waste, byproducts of agro industries and herbs which possessing brilliant medicinal properties have a great potential in replacement of synthetic dyes in textiles. The pomegranate rind, onion peel off, tamarind seed, etc are bio product of agro industries. *Sida-cordifolia* is such an herb found in abundant in nature, named as Bala in hindi and Sanskrit and have brilliant medicinal properties but rare literature have been found on its applications in textiles¹. Therefore, present study is an attempt to explore dyeing behavior of *sida-cordifolia* using different mordanting methods i.e. pre-mordanting, meta-mordanting and post-mordanting². Herb was treated with both chemical as well as natural mordants on woollen fabric by exhaust method on water shaker bath for a comparative study of their colouring behavior and fastness properties. Colour strength was evaluated using computer colour matching instrument and different fastness properties were evaluated as per the standards³⁻⁵.

Materials and Methods

Material Selection and Collection

The dye powder was extracted from the dry leaves of *Sida-cordifolia* herb, collected from Bhagat Phool Singh Mahila Vishvidyalaya Campus, Khanpur Kalan, Sonipat, Haryana, India. The picture of the herb is at Figure1.



Figure.1 Sida Cordifolia herb

Textile Material Used for Dyeing

Twill weaved woollen fabric was used for dyeing having EPI and PPI of 58, 62 respectively and weight of fabric was 295 gsm.

Mordant's Used

a) Natural Mordant's

1. Goose berry powder⁶
2. Harda powder⁷
3. Orange peel powder⁸

b) Chemical Mordant's

1. Copper sulphate
2. Ferrous sulphate.
3. Alum⁹⁻¹⁰.

Dye Powder Extraction Procedure

Dye powder was extracted using 20 g dry leaves powder in one liter of water and boiled for 45 minutes as shown in Figure 2. Residual colouring substrate was obtained as a filtrate¹¹⁻¹².

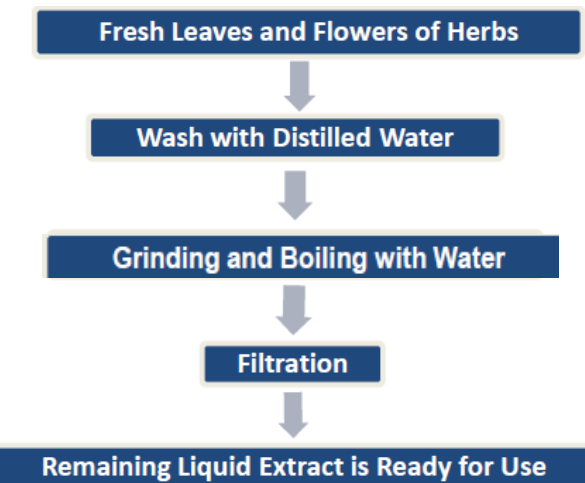


Figure 2: Extraction Procedure from herbs. [13-18]

Optimization of Dyeing Condition

Dyeing was carried out by optimizing the dye concentration, time, pH, temperature, mordant concentrations, MLR, etc. The optimized dye recipe is given in Table 1¹⁹⁻²⁰.

Table - 1
Recipe for Dyeing of Wool with Sida Cordifolia Dyes

Sida Cordifolia	10% owf
Mordant (in case of any synthetic mordant such as Alum, Copper Sulphate or Ferrous Sulphate)	20% owf
(in case of any natural mordant such as Dry Goose Berry, Harda or Orange Peel powders)	25% owf
Mordanting Procedure	Pre, Meta, Post
MLR	1: 40
pH of the dye bath	5 - 6.5
Temperature of dyeing	95 °C
Time of dyeing	1 hr

Fabric samples of wool were dyed with the help of various type of natural as well as synthetic mordants in pre, meta and post mordanting methods. After dyeing samples were washed with 2 gpl non-ionic soap solution at 70°C for 10 minutes and then rinsed thoroughly with cold water and dried²¹⁻²⁵.

Testing Methods

Measurement of Colour Attributes

The colour difference DE, colour value (L*, a*, b*) of the different dyed samples were determined using Datacolour spectrophotometer and Datacolour software interfaced with the computer²⁶. Illuminant D65, observer 10° and CIE 1976 were used. The instrument was standardized with a white tile. Hunter co-ordinates had been measured on the instrument of various samples i.e. L*, a*, b*. Where,

1. L signifies lightness (L+ -- more lighter, L- -- more darker)
2. a signifies redder or greener (a+ -- redder, a- -- greener)
3. b signifies bluer or yellower (b+ -- yellower, b- -- bluer)
4. $K/S = \frac{1-R}{2R}$
5. Colour Strength = $\frac{[(K/S)_{Batch} / (K/S)_{Standard}] \times 100$

The Kubelka–Munk theory gives the above said relation between reflectance and absorbance, where R is the reflectance, K is absorbance and S is the scattering²⁶⁻²⁸.

Colour Fastness

The various colour fastness such as wash, rubbing and light fastness were checked using IS: 3361- 1979, Test III, IS: 766- 1988 and IS: 2485-1985 test methods respectively²⁹.

Results and Discussions

The L*, a*, b*, K/S values and shade obtained of sida-cordifolia dyed fabric samples are shown in Table 2. It can be observed from the table that 'a' values are negative and 'b' values are positive for all the dyed fabrics, that means colour shades lie in the green-yellow co-ordinates. The colour values of undyed standard sample are as follows: L:77.170, a:-9.908 and b:6.887. It can be analyzed that all the dyed samples show excellent wash and rubbing fastness. Although woollen dyed sample shows moderate light fastness.

Table - 2
Colour Fastness and Colour Values of Sida Cordifolia Dyed Woollen Fabric

Mordanting Method	Mordant used in Dyeing of woollen samples with Sida Cordifolia							
	Colour Coordinates and Fastness Properties	Without Mordant	Dry Goose Berry Powder	Harda Powder	Orange Peel Powder	Copper Sulphate	Alum	Ferrous Sulphate
Pre	L	80.790	79.745	81.435	79.414	80.740	80.955	79.347
	A	-1.933	-1.315	-0.396	-1.599	-4.030	-2.238	-0.718
	B	16.994	15.616	19.014	13.662	17.335	17.591	13.929
	K/S	11.917	26.693	27.882	14.092	26.724	8.843	33.995
	W F	5	5	4	5	5	5	5
	L F	5	4	4	5	5	5	3
	R F	5	5	5	5	5	5	5
Meta	L	80.790	83.045	81.977	81.316	80.866	83.045	78.608
	A	-1.933	-3.885	-0.138	-2.818	-5.213	-3.885	-0.256
	B	16.994	22.139	20.622	17.852	17.322	22.139	11.928
	K/S	11.917	27.840	28.493	7.718	18.404	6.320	14.857
	W F	5	5	5	5	5	5	5
	L F	5	4	3	4	3	4	3
	R F	5	4	4	5	5	5	5
Post	L	80.790	80.120	82.071	82.170	82.373	85.471	78.940
	A	-1.933	-1.171	-0.182	-3.309	-5.908	-5.149	-0.545
	B	16.994	16.557	20.896	19.233	20.968	26.574	12.690
	K/S	11.917	11.672	9.386	17.291	8.317	17.204	22.086
	W F	5	5	5	5	5	5	5
	L F	5	4	4	5	5	5	3
	R F	5	5	5	5	5	5	5

WF: Wash Fastness; LF: Light Fastness; RF: Rubbing Fastness

It is clear from the results that all the three natural mordants also showed a good affinity with dye and gives darker or comparative similar depth of shades as compared to chemical mordants. The colour fastness values of all the dyed samples with natural mordants are good and comparable to synthetic mordants which shows that these eco-friendly natural mordants has great potential in eco-friendly dyeing.

The K/S values of Sida-cordifolia dyed woollen fabric by various mordants in different mordanting methods are plotted in Figure 3. It can be

analyzed from the graph that the process of mordanting is also a major factor for colour strength and other colour attributes of the dyed fabric³⁰. In case of mordants such as copper sulphate and ferrous sulphate pre-mordanting gives maximum K/S values. In dry goose berry and harda powder meta-mordanting gives maximum K/S values. Whereas in post-mordanting orange peel powder and alum gives maximum K/S values. Overall orange peel as well as alum mordant shows lower K/S values amongst all the six mordants evaluated.

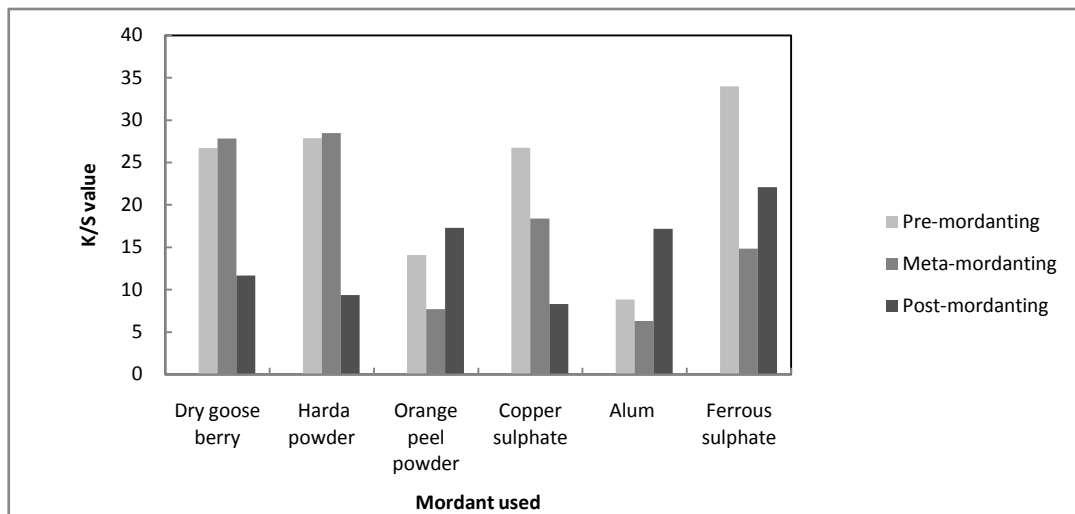


Figure 3: K/S Values of Sida-Cordifolia Dyed Woollen Fabric by Various Mordants

Conclusion

It can be observed that extract of *Sida cordifolia* natural dye gives various shades in green-yellow region on woollen fabric with the help of various chemical and natural mordants. As far as fastness properties concerned, both natural as well as chemical mordants shows good results. It can be also concluded from the above found results that whole dyeing process can be done using renewable eco-friendly natural materials. Therefore there is a great scope for eco-friendly dyeing of woollen textile materials with *Sida-cordifolia*.

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