

Improved Fastnesses through Modified Turmeric Dyeing using Rare Earth Salts As Mordants

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Abstract

Turmeric dyeing of silk fabric with Rare earth salts as mordants has been attempted to improve the wash and lightfastness of dyed fabrics. Two different mordanting methods were adapted- pre and post mordanting with 6 different rare earth salts, namely Cerium nitrate, Lanthanum carbonate, Yttrium oxide (series-1), Cerous sulphate, Lanthanum chloride and Yttrium chloride (series-2). A conventional mordant- alum was also used for comparison. The silk fabric (RFD) was used for dyeing with the same concentration of Turmeric dye to assess the effect of Rare earth salts on the colour strength of the dyed fabric and fastness properties.

Keywords

Turmeric dye, Cerium, Lanthanum and Yttrium salts mediated natural dyeing, improved fastnesses

1.0 Introduction:

Turmeric dyeing has always posed a challenge to dyers. The colour adherence and retention of the dyed fabric is a major concern. It is known to us that reflectance is inversely proportional to absorbance, so when absorbance is less, reflectance is more and vice versa. Shade percentage often influences the reflectance percentage of the dyed fabrics. The colour strength of a dye is a measure of its ability to impart colour to the dyed material. This property is characterized by the absorption in the visible region of the spectrum and can be expressed as a colour strength value. Colour strength (K/S) is the most important parameter to test the quality measurement of a sample in terms of the depth of the colour dyed fabric. The natural dye extracted from Turmeric was used for dyeing cotton at different dyeing conditions by Umbreen et al [1]. The fastness properties of the dyeing showed to have good saturation and rubbing fastness, but poor washing and light fastness properties on cotton without any mordant. However, when the dyeing was done with mordants, washing and light fastness properties improved while rubbing fastness exhibited deterioration. Adeel et al [2] observed that UV radiation enhances the colour strength of dyed fabric which was irradiated using a low concentration of dye. The colour fastness properties of

dyed fabrics which were pre-irradiated cotton fabric and dyed by using pre-irradiated Turmeric powder was found to be good. Shukla and Vankar [3] attempted to activate the Curcumin molecule by complexation with chitosan. The binding took place at intrinsic pH (7–8) very effectively without any surfactant or enzyme. Dyeing with this composite showed excellent wash and light fastnesses as compared to Curcuma dye. Improved fastnesses and wash cycle sustenance were observed.

This research aims to find solutions to three major problems commonly faced with Turmeric dye. We were focussing on the following points. They are -1. Are there simpler ways to make Turmeric dye non-fugitive? 2. How can dye depths be increased for dyed fabric? 3. How can we enhance the wash and light fastnesses of Turmeric dyed fabric?

2.0 Materials and Methods

2.1 Materials

Turmeric powder was procured from the local market (MDH), Rare earth (RE) salts, namely Cerium nitrate, Lanthanum carbonate, Yttrium oxide, Cerous sulphate, Lanthanum chloride and Yttrium chloride were procured from Indian Rare Earths Ltd. (IREL), Head Office, Mumbai. Ezee soap solution was procured from the local market, it was used for washing the dyed silk fabrics. Citric acid was procured from Merck. Silk fabric was purchased from Sanjay Shah and Associate Company.

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2.2 Methods

2.2.1 Mordanting

The process of mordanting was carried out by adopting the pre-mordanting method using 1 % of the mordant solution and maintaining a 1:30 material-to-liquor ratio. The process of pre-mordanting was carried at 50–55 °C with gentle stirring and continued for 45 minutes, for the mordants-Cerium nitrate (CN), Lanthanum carbonate (LC), Yttrium oxide (YO) the process of pre-mordanting was with 1:1 solution made with citric acid (CA) and RE salt (Series-1) and the process for Cerous sulphate (CS), Lanthanum chloride (LC) and Yttrium chloride (YC) using only RE salts (Series-2). It was carried out similarly. For post-mordanting, the Turmeric dyed swatches were prepared and then the mordanting with RE salts: CA (Series-1) and RE salt (Series-2) were carried out. Time and temperature of mordanting were kept the same as pre mordanting method.

2.2.2 Extraction of Turmeric dye

The dye was prepared by taking 5 % of the Turmeric powder concerning on weight of fabric (OWF) of the silk swatches. The powder was heated in deionized water for 30 minutes and then filtered. The filtrate was used directly for dyeing the silk fabric.

2.2.3 Dyeing of the silk fabrics

The process of the dyeing was carried out in a water bath by maintaining the material-to-liquor ratio of 1:30 for silk fabric. All the test fabrics were dipped in 200 ml of dyeing solution of 5 % dye concerning on weight of fabric (OWF) at 50-55°C temperature. The material was then removed and washed with 1 % of mild detergent (Ezee) and water 2–3 times followed by drip-drying operations at room temperature.

2.2.4 Measurement of reflectance (%) & colour strength (K/S)

Reflectance (%) of the dyed fabric samples were measured by using a Premier Colour scan spectrophotometer. As the strength of any dye is related to its absorption property, so by using Kubelka–Munk formula the following relation between reflectance and absorbance can be derived:

$$K/S = \left[\frac{1-R}{2R} \right]$$

Where R is the reflectance, K is absorbance and S is the scattering. By using the above equation colour strength of different Turmeric dyed samples were measured.

2.2.5 Fastness properties of the dyed silk fabric

The standard procedure ISO: 105 C: 10 was followed to measure the washing fastness. Launder-o-meter was used to washing the samples. fathometer with xenon arc lamp was used to test the lightfastness with the standard procedure ISO: 105- B02: 2014.

3.0 Results and Discussion

3.1 CIE Lab and K/S values of Turmeric dyeing samples

The Rare earth mordants of series-1 were used for pre and post mordanting and dyed swatches of silk using turmeric as the natural dye source. The results are shown in Table 1. Table 1 shows the CIELab values, K/S values and ΔE . The best dyeing results were obtained from pre mordanted Cerium nitrate/citric acid sample.

{Series 1: Standard – Control, Batch-1 Alum pre mordanted, Batch-2 Alum post mordanted, Batch-3 Cerium nitrate/Citric acid pre mordanted, Batch-4 Cerium nitrate/Citric acid post mordanted, Batch-5 Lanthanum carbonate/Citric acid pre mordanted, Batch-6 Lanthanum carbonate/Citric acid post mordanted, Batch-7 Yttrium oxide/Citric acid pre mordanted and Batch-8 Yttrium oxide/Citric acid post mordanted}

Table-1 CIELab and K/S values of Turmeric dyeing samples (Rare earth pre and post mordanted) Series-1

S. No	Name	K/S	L*	a*	b*	C*	H*	ΔE^*	Remark
1	Standard	95.36	76.94	7.16	85.46	85.75	85.17	--	
2	Batch-1	98.32	80.61	5.57	93.28	93.45	86.17	8.79	
3	Batch-2	104.35	78.24	4.96	91.01	91.15	86.84	6.12	
4	Batch-3	120.37	82.99	6.21	101.75	101.94	86.47	17.41	Best
5	Batch-4	95.37	83.54	1.20	96.13	96.15	89.25	13.89	
6	Batch-5	120.10	81.16	8.50	99.38	99.74	85.07	14.61	
7	Batch-6	82.41	83.11	1.84	93.17	93.19	88.83	11.22	
8	Batch-7	95.39	83.43	2.60	96.53	96.57	88.41	13.62	
9	Batch-8	74.09	84.48	-0.85	93.46	93.47	90.56	13.61	

The Rare earth mordants of series-2 were used for pre and post mordanting and for dyed swatches of silk using Turmeric as the natural dye source. The results are shown in Table 2. Table 2 shows the CIELab values, K/S values and ΔE . The best dyeing results were obtained from pre mordanted Cerous sulphate sample.

However, grades of the mordanted samples recorded showed better results than that of the unmordanted samples. In most of the RE, salts pre-mordanting was found to be better in terms of K/S values, however, in the case of alum, it was

posted mordanting which gave better results in the case of series-1 and 2 of RE salts. Only Yttrium chloride of series-2 showed better results in post mordanting.

{Series 2: Standard – Control, Batch-1 Alum mordanted, Batch-2 Alum post mordanted, Batch-3 Cerous sulphate pre mordanted, Batch-4 Cerous sulphate Post mordanted, Batch-5 Lanthanum chloride pre mordanted, Batch-6 Lanthanum chloride post mordanted, Batch-7 Yttrium chloride pre mordanted and Batch-8 Yttrium chloride post mordanted}

Table-2 CIELab and K/S values of Turmeric dyeing samples (Rare earth pre and post mordanted) Series-2

S. No	Name	K/S	L*	a*	b*	C*	H*	ΔE^*	Remark
1	Standard	100.06	78.87	5.67	89.61	89.79	86.34	--	
2	Batch-1	82.62	80.48	3.72	88.82	88.90	87.56	2.65	
3	Batch-2	104.34	78.23	4.96	91.01	91.15	86.84	1.69	
4	Batch-3	119.60	81.70	5.68	99.15	99.33	86.58	9.95	Best
5	Batch-4	102.92	78.56	1.68	89.96	89.97	88.89	4.01	
6	Batch-5	114.37	76.69	8.50	99.38	99.74	85.07	7.08	
7	Batch-6	97.50	75.58	10.07	85.00	85.60	83.20	7.17	
8	Batch-7	91.08	78.77	6.96	87.32	87.60	85.40	2.63	
9	Batch-8	100.37	75.54	9.43	84.97	85.49	83.62	6.84	

3.2 Fastness properties of the Dyed silk fabrics

Table-3 Fastness properties of silk swatches

Turmeric dyed samples	Wash Fastness		Light Fastness	
	Pre mordanting	Post mordanting	Pre mordanting	Post mordanting
Control	3	3	1	1
Alum	4	4	1	1
Cerium nitrate	4-5	4-5	1	2
Cerous sulphate	4-5	5	1	2
Lanthanum carbonate	4-5	4-5	1	1
Lanthanum chloride	3-4	3-4	1	1
Yttrium oxide	4-5	5	1	2
Yttrium chloride	3-4	3-4	1	1

The colour fastness is determined and shown in table -3. The retention of the dye by the fabrics when exposed to different tests recorded yield the grades, indicating whether or not there has been efficient retention. The silk fabrics dyed with Turmeric dye recorded fair, fair to good, grades in the washing tests shown in table 3. Lightfastness recorded also showed improvement in the case of postmordanted cerium salts (nitrate and sulphate), as well as post mordanted yttrium oxide silk swatches. The overall retention of the dye in combination with the different RE salt mordants showed the least fading and bleeding. However, the unmordanted dyed samples also showed satisfactory K/S, but the fastness properties were poor. The washing fastness of the dyed silk swatches with RE salts showed good influence on the rate of

the diffusion of the dye and the state of the dye which has penetrated and its adherence. The Colour strength (K/S) of the dyed fabric has been found to influence fastness value. In this research, a relation was found between Colour Strength (K/S) and dye adherence.

4.0 Conclusion:

The three objectives were fulfilled as the dyed silk swatches with RE salts showed good dye adherence and washing fastness. Lightfastness improved marginally. Work is in progress to make it better. Thus it can be concluded that using RE salts in conjunction with Turmeric dye seems to be an industrially viable proposition.

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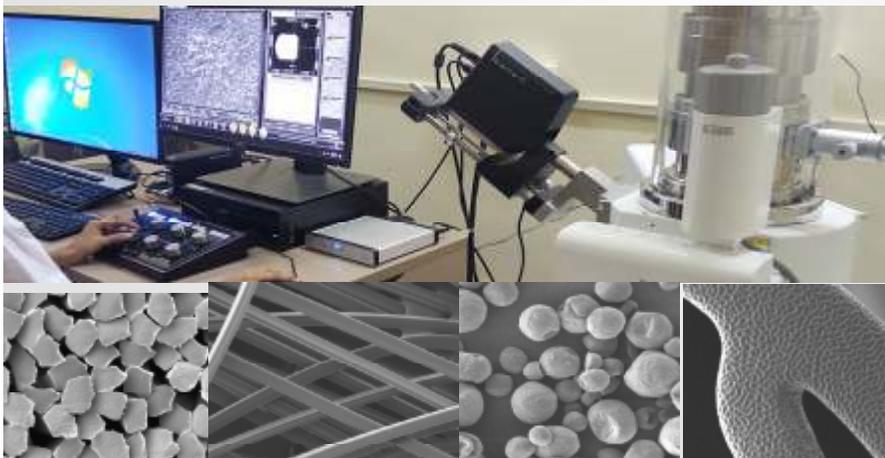
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