

## Natural Dyes for Colouring Cotton and Silk Fabrics

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### ABSTRACT

*Application of dyes or pigments on textile materials such as fibers, yarns, and wool with the goal of achieving color with desired color fastness is one of the oldest technique man has discovered, however synthetic dyes have found its way in the present day. . Dyes from plants are one of the most unique uses of the plants. In the present study various ranges of dyes extracted from the flowers of plants like, Hibiscus rosa-sinensis L., Impatiens balsamina L. rhizome of Curcuma longa L., leaves of Lawsonia inermis L., and fruits of Rivina humilis L., were used for coloring cotton and silk fabrics. Results showed that cotton fabric exhibited good natural dye retaining capacity when compared to silk fabric.*

**Keywords:** Cotton, Dye, Extract, Fastness, Mordant, Silk

### 1. Introduction

Nature has gifted us with many dye yielding plants. Use of natural dyes has been growing rapidly due to the harmful effects of synthetic dyes. Moreover, many countries already have imposed rigorous environmental rules over these dyes. Germany has banned the azo dyes (synthetic dye) [1]. In this situation, a higher demand is put towards the greener alternatives or agricultural residues [2]. Using natural dyes in the coloration process in textile industry can be a step towards a new era of less polluting processing of fabrics [3]. Vegetable products were used in dye extraction such as onion –outer shell, red beetroot, orange rind, pomegranate rind, banana peel used by the people of South American, African and Asian countries [4,5,6]. Above all, they are eco friendly and can be recycled after use. The objectives of the present study are i) to extract dye from local plants. ii) to study the dye ability of silk and cotton using different mordants. iii) to study the fastness properties of these dyes on silk and cotton fabrics.

### 2. Materials and Methods

#### 2.1. Collection of plant material

The flowers of *Hibiscus rosa-sinensis* L., *Impatiens balsamina* L. rhizome of *Curcuma longa* L., leaves of *Lawsonia inermis* L., fruits of *Rivina humilis* L. were used to extract dye. The plant specimens were identified with the help of local and regional floras [7,8]. In order to check the spelling, eliminate the use of older synonyms and ensure uniform nomenclature all plant names were verified using [9].

### **2.3. Dye Extraction**

The collected plant materials used for extraction of dye. The cleaned samples (50g) were crushed and then boiled with 100 ml of water for 30 mins in a hot water bath for quick extraction of dyes. At the end of 30 minutes, the total color was extracted. The hot solution was filtered and a clear solution was obtained which is used for dyeing cotton and silk fabric. [10]

### **2.4. Dyeing materials**

Cotton and silk fabrics were used to test the dyeing ability of plants dyes.

### **2.5. Preparation of Mordant**

#### **2.5.1. Alum**

0.748g of Alum and 0.187g of washing soda were mixed in 100ml of water and was stored for further use.

#### **2.5.2. Vinegar**

50 ml of 5% acetic acid is mixed with 100ml of water. From this, 25ml was taken and mixed with 100ml of distilled water.

#### **2.5.3. Salt**

5 g of Sodium chloride was mixed in 100ml of distilled water and was used as a mordant and stored for further use.

### **2.6. Premordant Dyeing**

Sodium chloride, vinegar and alum were used as mordants. The extracts obtained were filtered and used for dyeing fabric material. The fabric materials used for dyeing were first washed with clean water. Then the fabric materials were transferred to fixative (mordants)- 100ml salt/ 125 ml vinegar/100 ml alum and allowed to boil for one hour at 100° C. The fabric material was simmered in the fixative for at least an hour. The fixed fabric was immersed in the extracted plant dye. It was then boiled and simmered until the fabric takes up the dye at least for an hour. After an hour, the fabric is carefully pulled out from the simmering fixative and is squeezed out completely. The fabric is then placed on the newspaper or tile to dry. The shade dried fabric were further evaluated for its light, rub and wash fastness. Wash fastness was tested by washing with soapy water (Jihad, 2014). [11]

### **2.7. Evaluation of Colour Fastness**

Colour fastness of the dyed fabric samples was determined as per ISO: 105-A02 – 1995 method using a launder-O-meter following ISO-3 wash fastness method. The wash fastness rating was assessed using grey scale as per ISO-105-A02 (loss of shade depth) and ISO-105-A03 extent of staining. Colour fastness to rubbing (dry and wet) was assessed by hand rubbing the fabric one sample ten times and grey scale as per ISO-105-A03 extent of staining.

### 3. Results and Discussion

In the present study, the plant dyes yield bright colour shades when dyed in silk and cotton fabrics. The flowers of *Hibiscus rosa-sinensis* produced red colour extract and on dyeing, it produced an orange red to violet shades on different textile material studied. Among the mordants used, the best colour developed was in alum which gave dark violet colour in cotton. The salt and alum treated dyes were tolerant to washing and showed good light and rub fastness. The red-colored dye extracted from *Impatiens balsamina* flowers gave different shades of pink and brown colors on the selected fabrics. Vinegar and alum treated fabrics showed good washing, rubbing and light fastness than the mordant salt.

**Table 1. Plants that yielded substantive dyes**

Sl. No	Binomial name	Family	Dye yielding plant part
1	<i>Curcuma longa</i> L.	Zingiberaceae	Rhizome
2	<i>Hibiscus rosa-sinensis</i> L.	Malvaceae	Flowers
3	<i>Impatiens balsamina</i> L.	Balsaminaceae	Flowers
4	<i>Lawsonia inermis</i> L.	Lythraceae	Leaves
5	<i>Rivina humilis</i> L.	Phytolaccaceae	Fruits

The *Rivina humilis* fruits yield a light red color dye. Various shades of brown were observed in both cotton and silk materials. The leaves of *Lawsonia inermis* yielded a brown colored dye. Various shades of brown color were imparted in cotton and silk fabrics, but there is no color developed in silk treated with salt and vinegar except alum treated cotton cloth exhibited coffee brown shade. Good fastness observed in cotton treated with alum. Similar findings were recorded by [12]. The process is economically viable as the raw materials are available at low cost and so cost of production is also very low. Similar findings were reported in marigold, China rose and *bixa* flower [13].

**Tabl 2. Plant synthesized color dyes using different mordants**

Sl. No	Binomial name	Family	Dye yielding plant part	Fabric material	Vinegar	Sodium chloride	Alum
1	<i>Curcuma longa</i> L.	Zingiberaceae	Rhizome	Cotton	Dark yellow	Yellow	Yellow
				Silk	yellow	Shining yellow	Shining yellow
2	<i>Hibiscus ros a-sinensis</i> L.	Malvaceae	Flowers	Cotton	Red	Red	Dark blue
				Silk	Light red	Shining red	Light blue

3	<i>Impatiens balsamina</i> L.	Balsaminaceae	Flowers	Cotton	Pink	Pink	Light pink
				Silk	Light pink	Light pink	Pale pink
4	<i>Lawsonia inermis</i> L.	Lythraceae	Leaves	Cotton	Greenish brown	orange	brown
				Silk	Pale greenish	Light orange	Light brown
5	<i>Rivina humilis</i> L.	Phytolaccaceae	Fruits	Cotton	Pink	Dark pink	Pinkish yellow
				Silk	Light pink	Shining pink	Pale yellow

Based on the results an observation made that the cotton fabric material developed good colours with alum, vinegar and sodium chloride mordants when compared to silk fabric material [14]. These mordants when added to the dye gave different shades of color and thus enable us to make different types of shades from one plant using the mordant. The mordants alum and cream of tartar is directly added to the dye, whereas, in case of vinegar and salt the cloth is treated with those mordants and then it is immersed into the dye. This gives better results than directly adding the mordant into the dye. Some plants may have more than one color dependent upon which part of the plant one uses. Dyes don't combine directly with the substance they are intended to color. A mordant is required to make the color hold. Mordants are materials that cause the natural dyes to bond chemically with the cloth, preventing the color from either fading with exposure to light or washing out [15]. Mordant dyes are acid dyes having chelating sites to form stable coordination complex with metal ions from metal salts (mordants). Dyes can form chelates with different mordants to develop various shades with superior wash fastness [16].

### 3.1. Fastness results

Wash, light and rub fastness tests were conducted to determine whether the identified dyes would withstand washing and drying when used to color everyday clothes. Color Fastness is one of the important tests for fabric material as proper dyeing will impart good wash, rub and light fastness properties [17].

**Table 3. Colour fastness of dyed fabrics using NaCl as mordant**

Sl. No	Binomial name		Fastness											
			Wash fastness				Light fastness				Rub fastness			
			1	2	3	4	1	2	3	4	1	2	3	4
1	<i>Curcuma longa</i> L.	Cotton				✓				✓				✓
		Silk				✓				✓				✓

2	<i>Hibiscus rosa-sinensis</i> L.	Cotton			✓					✓				✓
		Silk			✓					✓				✓
3	<i>Impatiens balsamina</i> L.	Cotton		✓					✓					✓
		Silk		✓					✓					✓
4	<i>Lawsonia inermis</i> L.	Cotton		✓					✓					✓
		Silk		✓					✓					
5	<i>Rivina humilis</i> L.	Cotton	✓						✓					✓
		Silk	✓						✓					✓

Table 4. Colour fastness of dyed fabrics using vinegar as mordant

Sl. No	Binomial name		Fastness											
			Wash fastness				Light fastness				Rub fastness			
			1	2	3	4	1	2	3	4	1	2	3	4
1	<i>Curcuma longa</i> L.	Cotton				✓				✓				✓
		Silk				✓				✓				✓
2	<i>Hibiscus rosa-sinensis</i> L.	Cotton			✓					✓				✓
		Silk			✓					✓				✓
3	<i>Impatiens balsamina</i> L.	Cotton		✓					✓					✓
		Silk		✓					✓					✓
4	<i>Lawsonia inermis</i> L.	Cotton		✓					✓					✓
		Silk		✓					✓					✓
5	<i>Rivina humilis</i> L.	Cotton	✓						✓					✓
		Silk	✓						✓					✓

Table 5. Colour fastness of dyed fabrics using alum as mordant.

Sl. No	Binomial name		Fastness											
			Wash fastness				Light fastness				Rub fastness			
			1	2	3	4	1	2	3	4	1	2	3	4
1	<i>Curcuma longa</i> L.	Cotton				✓				✓				✓
		Silk				✓				✓				✓
2	<i>Hibiscus rosa-sinensis</i> L.	Cotton			✓					✓				✓
		Silk			✓					✓				✓
3	<i>Impatiens balsamina</i> L.	Cotton		✓					✓					✓
		Silk		✓					✓					✓
4	<i>Lawsonia inermis</i> L.	Cotton			✓				✓					✓
		Silk			✓									✓
5	<i>Rivina humilis</i> L.	Cotton	✓						✓					✓
		Silk	✓						✓					✓

### 3.2. Washing fastness

Most natural colors were found to show market acceptable wash fastness. It was however observed that fading was more or greater for the fabrics with the solid detergents probably due to the presence of bleaching agents in the detergents and the selectively higher pH of the solutions of the solid detergents. More importantly, fixing the dyes with detergents gave us an insight regarding the dye-detergent relationship. That is an intense shade was developed after the fabric was brought to the fastness testing. This may be due to the instability of the dye molecules, which resulted in a change of shade and colour strength on the fabrics once the dyes were exposed to the conditions used in the fastness testing [18]. The results of washing and light fastness of the dyed fabrics are shown in table 3. Variable color shades were formed on both silk and cotton fabrics after fastness tests. *Curcuma longa* gave excellent(4) wash fastness in all the mordants *Hibiscus rosa-sinensis* recorded a good(3) wash fastness on both cotton and silk in the selected mordants. *Impatiens balsamina* gave a weak(2) result in vinegar, sodium chloride and alum mordants. *Lawsonia inermis* exhibited a good (3) wash fastness result in alum and weak (2) result in sodium chloride and vinegar. *Rivina humilis* recorded a poor (1) wash fastness result in all the mordants

### 3.3. Light fastness

The mordants vinegar and alum mordanted samples dyed with *Curcuma longa* and *Hibiscus rosa-sinensis* showed excellent (4) light fastness on both cotton and silk fabrics. *Impatiens balsamina*, *Lawsonia inermis* and *Rivina humilis* showed good (3) light fastness results in the three mordants. The salt, alum and vinegar treated dyes were tolerant to washing and showed good washing fastness. It also had a good light and rub fastness.

### 3.4. Rub fastness

In dyed and printed textile materials the unfixed dye particles are mechanically held on the surface and these particles are rubbed off easily on the wearer skin or any other cloth of contact. So it is necessary to determine the rubbing fastness of dyed or printed textile materials.

In the present study, dyed fabrics from all the plant materials *Curcuma longa*, *Hibiscus rosa-sinensis*, *Impatiens balsamina*, *Lawsonia inermis* and *Rivina humilis* recorded good (3) and excellent(4) results with all the three mordants in rub fastness test. All the mordants showed moderate washing, rubbing and light fastness except the silk treated with vinegar showed poor fastness. *Curcuma longa* and *Hibiscus rosa –sinensis* dyes show no change in colour after wash fastness test, indicating their ability to withstand laundering. This suggests their viability as dyes for colouring everyday clothes. Findings of [19] too are concordant with those of the present study. Fastness test has been observed that the washing

conditions also cause shade changes on dyed fabrics [20].

#### 4. Conclusion

In the present study of various ranges of dyes extracted from ten plant materials. *Curcuma longa*, *Hibiscus rosa-sinensis*, *Impatiens balsamina*, *Lawsonia inermis* and *Rivina humilis* were the plants used for the extraction of dyes. NaCl, vinegar and alum are mordants used as fixatives of dyes. Plant parts like bract, flower, peel rhizome and leaf were used for extracting dyes. Fabrics like cotton and silk were used for dyeing. *Curcuma longa* and *Hibiscus rosa-sinensis* dyes show no change in colour after wash fastness test. In the present study, the peel of The leaves of *Lawsonia inermis* yield a brown colored dye. Various shades of brown color were observed in cotton and Silk fabrics, but there is no color developed in silk treated with salt and vinegar except alum treated cotton cloth exhibited coffee brown shade .Good rubbing, light and wash fastness observed in all the three mordants. Dark yellow colour shades were obtained from a yellow dye extracted *Curcuma longa*. All the ten plants dyes show excellent results in rub fastness test. Cotton fabric shows good retaining capacity of natural dye when compared to silk fabric. Colour yields were found to be influenced by the addition of mordants. Alum and vinegar treated fabrics shows good retaining capacity and shows bright colours in the dyed cloths. This study is a key of searching the alternative to satisfy the consumers growing demand of eco-friendly products and progress has been made with this study in use of plant dyes. Thus on the basis of the results, it can said that plant dyes used in the present study for dyeing have good scope for application on cotton and silk fabrics.

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