

# APPLICATION OF ECO-FRIENDLY NATURAL DYE FROM CAESALPINIA PULCHERRIMA ON COTTON FABRIC

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## Abstract

Natural dyes are mostly preferred by people and gaining sudden popularity in recent past due to the inherent benefits of human health and hygiene. The dyes and chemicals used in textiles have led to serious threat to the environment also. This in turn created the rising demand for sustainable textile products. Sustainable dyeing of cotton fabric with caesalpinia pulcherrima flowers both yellow and red colours was experimented. Optimization of dye extraction was tried and finally optimized parameters were followed to dye the desized cotton fabric. Natural mordants such as mango bark, pomegranate peel and myrobalan powder were used in two percent concentration. The dyed cotton fabric was evaluated for Physical parameters such as weight, thickness, stiffness, drape, tensile strength and elongation. Wettability and Absorbency tests were also carried out. Colour fastness to dry and wet crocking and washing fastness were measured. Dyed cotton fabric showed excellent physical, wettability and absorbency properties. Dry crocking of dyed cotton samples was excellent.

## Key Words:

*caesalpinia pulcherrima, desizing, mordanting, optimization, colour fastness*

## 1.INTRODUCTION ( Size 11 , cambria font)

Colour is one of the nature's components that made human life more esthetic and interesting in the world. It is meant to be associated with our life's emotions,

seasons, human qualities, festivals and passion. In the past, the people tried to decorate their surroundings at the dawn of civilization similar to those of natural colours found in the plant, soil, sky and other sources. It gave birth to a new study of natural colours (Vankar, 2016).

All the dyes used for textile goods were naturally procured until the mid, until Perkin's discovery of mauvine in 1856. Since then, the development of synthetic dyes hasn't looked back since they were cheap, available in a lot of different colours, strong colour-fastness and were easy to manufacture most of all. The textile industry is accounts for 1.3 million tons of dyes and pigments being used and manufactured, most of which are made synthetically (Konwar and Boruah, 2020). All around the world the textile industry is responsible for discharging effluent in the water bodies to a larger extent. This has led to the conscious concern to pose strict regulations for protecting the environment. Textile dyeing is possible in a green way with the use of natural resources and eco friendly dyeing processes. In recent years the rising demand for natural dyed textile products and sustainable colouring processes are emerging. Eco-friendly concepts are emerging in textiles which lead to eco-revolution (Deo, 2001).

## OBJECTIVES

The Objectives of the present study are to

- utilize *Caesalpinia pulcherrima* flowers for natural dyeing
- optimize dye extraction and dyeing parameters
- dye the cotton fabric using the selected flower extracts
- evaluate the dyed cotton fabrics.

### 1.1 Methodology

Cotton fabric was selected for the study. Cotton fabric was purchased at the cost of Rs. 60/m from the retail shop at Coimbatore. The selected material was desized in a bath containing 2% of detergent and 0.5% of wetting agent in 1200ml of water MLR 1:20 at 90°C for 1½- 2 hrs. After desizing the materials were washed in running tap water, dried and used for further processing.



**Fig 1. *Caesalpinia pulcherrima***

The yellow and red flowers of *caesalpinia pulcherrima*(Fig.1) were collected and washed thoroughly with cold water to remove dirt. They were kept for drying in shade until they get dried and the dried flower was ground into powder with the help of grinding machine. The ground powder was stored in an airtight container for extracting dyes.

Mango bark, Pomegranate peel and Myrobalan powder were selected as mordants owing to their tannin content. The selected mordants were collected and kept for drying in shade until they get dried. The dried mordant materials were ground into powder and stored in an airtight container for further use.

### 1.2 Optimization Parameters for dye extraction and dyeing

Alkaline extraction method was followed to extract dye from yellow and red flowers of *Caesalpinia pulcherrima*. Five concentrations of dye materials, i.e, 2%, 4%, 6%, 8%, and 10% were prepared in alkaline medium. Each of the concentration was tried by varying time of dye extraction for 30, 60 and 120 minutes respectively. Based on colour yield, 4 percent dye concentration with 60 minutes of extraction was selected.

For dyeing ,five different temperatures i.e, 30°C, 45°C, 60°C, 75°C and 90°C were tried and finally 45°C was found to be effective. Dyeing time was fixed as 45 minutes after experimenting with 15 , 30 , 45, 60 and 75 mins of time duration. pH level was maintained at 9 after trials starting from pH 5 to12. Optimized parameters for the selected red and yellow flower dye extraction and dyeing of cotton fabric.(Table I)

The flower dyes were extracted from the natural source using alkaline method based on optimized parameters as given in Table I. Two percent mordant solution from mango bark, pomegranate peel and myrobalan was prepared by boiling the contents in aqueous medium. Simultaneous mordanting technique was followed. Then the filtered dye extracts was thoroughly mixed with two percent mordant solution. Finally cotton fabric was dyed in dip and dry method.

After dyeing process, the dyed fabric was washed thoroughly and then allowed to dry in shade. Each of the natural sources used in textile dyeing require various dyeing methods and it has been a challenge to the dyer. (Samanta and Agarwal, 2009) The need to develop standard dye extraction and standardization

Dyeing variables	Selected proportion
Dye extraction medium	Alkaline
Dye concentration (%)	4
Dye extraction time (minutes)	60
Dyeing time (minutes)	45
Temperature (°C)	45
pH	9
Material liquor ratio	1:20

procedure for natural dyeing on textiles is a must.(Gupta, 2019)

**Table I**  
**Optimization of dye extraction and dyeing**

The dyed cotton fabric was evaluated for Physical parameters such as weight, thickness, stiffness, drape, tensile strength and elongation. Absorbency tests were also carried out. To assess the colourfastness properties, aspects like crocking (Dry and wet) and washing fastness were measured. The nomenclature of the samples are as follows;

DC	- Desized cotton
YFDC	- Yellow flower dyed cotton
YFMDC	- Yellow flower mordant dyed cotton
RFDC	- Red flower dyed cotton
RFMDC	- Red flower mordant dyed cotton

## 2. Findings of the study

It is noticed that the weight of all dyed samples has shown increase in fabric weight when compared to desized original cotton fabric. Sample YFDC seem to exhibit more weight (152.23 gm/sq.mt) than the other

samples. Percent weight gain of the dyed samples ranged from 7 to 13 percent.

**Table II**  
**Weight, thickness and stiffness of Undyed and dyed cotton fabrics**

Sample	Mean weight (gm/sq.mt)	Mean thickness (mm)	Mean stiffness (cm)
DC	131.47	0.31	2.28
YFDC	152.23	0.333	2.56
YFMDC	144.17	0.357	2.12
RFDC	142.64	0.313	2.50
RFMDC	142.99	0.331	2.51

Increase in fabric weight may be due to the adherence of dye in the fabric and compactness of yarn during wet processing. Thickness of the dyed cotton fabric increased when compared to desizing cotton fabric. This might be due to the adherence of dyed particles and closer arrangement of warp and weft yarns upon dyed process.

Fabric thickness of 0.357 mm was noticed in the YFMDC sample where as the original fabric thickness was noted to be 0.31 mm resulting in 13.16 % increase in thickness of dyed cotton fabric. It is clear that the stiffness of the dyed cotton fabric decreased when compared to desized fabric. Stiffness of control fabric was noted to be 2.24cm. Stiffness of dyed cotton fabric decreased by 10.75 per cent which in turn increase the drapability of the fabric.

Drapability of dyed cotton fabric increased (Table III) when compared to the desized cotton. Drapability of control fabric was noted to be 45.7 mm whereas

drapability of dyed cotton fabric increased by 1.93 per cent as noticed in sample YFDC. Though the increase in drape coefficient was very minimum, dyeing with the selected natural sources did not affect the drapability of the dyed cotton fabric.

**Table III**

**Drape, Strength and Elongation of undyed and dyed cotton fabrics**

Sample	Mean Drape Coefficient (%)	Mean strength (Kg/cm <sup>2</sup> )	Mean Elongation (cm)
DC	45.7	22.0	2.3
YFDC	46.6	23.7	2.4
YFMDC	46.4	25.6	2.6
RFDC	46.3	23.9	2.7
RFMDC	46.2	25.4	2.6

Mean Tensile strength of all dyed cotton fabrics has increased from 23.7 to 25.6 kg/cm<sup>2</sup> when compared to the control fabric (22.0 kg/cm<sup>2</sup>). Mean elongation of the desized cotton was 2.3cm whereas the same factor was higher among the dyed cotton fabrics. Among all the dyed fabrics, elongation of sample RFDC was noted to be 2.7cm.

**Table IV**

**Wettability and Absorbency of undyed and dyed cotton fabrics**

Sample	Mean absorbency (seconds)	Mean wicking (cm)	Mean sinking time (sec)
DC	3	0.7	2
YFDC	2.59	1.7	1.67
YFMDC	2.7	1.6	1.65
RFDC	2.1	1.6	1.72
RFMDC	1.2	1.5	1.70

Absorbency of cotton fabrics (Table IV) has increased after dyeing with natural extracts. Absorbent time of dyed cotton fabric RFMDC was much lower (1.2 seconds) when compared to DC (3 seconds). On comparing with DC (0.7cm), wicking factor of all dyed samples is enhanced (1.5 to 1.7 cm).

Considerable difference was also observed among sinking characteristics of dyed cotton fabrics. Time taken for sinking was improved by 16-21 percent. All above wettability and absorbency factors of dyed cotton fabrics directly contributes to the excellent comfort properties.

**TABLE- V**

**Colour Fastness to Washing and Crocking**

Sample	Colour fastness to Washing	Colour fastness to Crocking	
		Wet	Dry
DC	4	4	5
YFDC	4	4	5
YFMDC	4	4	5
RFDC	4	4	5
RFMDC	4	4	5

**5-Excellent 4-Very Good 3-Good 2-Fair 1-Poor**

The colour yielded by the selected flower sources ranged from yellowish brown and reddish brown. Gulrajani and Gupta, (1992) reported various colours produced by natural plant based sources through successive experiments. Fastness to dry crocking of dyed cotton fabric shown excellent result followed by very good fastness to wet crocking and washing. Results clearly indicate that natural colour could be retained by careful handling and washing of cotton fabrics dyed with selected flower extracts. Colour retention of dyed cotton fabric is based on its exposure to dyeing time.(Barker et al.,2019)

### 3. CONCLUSIONS

Dyeing of textiles with natural colourants is possible to a greater extent. Sustainability of naturally coloured fabric can be obtained with the use of natural mordants. Cotton fabrics dyed with natural extracts of *caesalpinia pulcherrima* and natural mordants. Dyeing using flower extracts enhanced the physical and mechanical properties of the cotton fabrics. Colour fastness to dry crocking was found to be excellent. Natural extract used in combination with natural mordants was effective on cotton fabrics.

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