

## Extraction of Ecofriendly Dye from Red Color Flowers of *Caesalpinia pulcherima* for Dyeing Cotton Fabrics



Chemistry

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### ABSTRACT

Dyeing is a process in which the coloring matter is directly applied on fiber. The customers opt for cotton fabrics which were dyed using natural colors. Synthetic dyes also cause pollution problem right from their synthesis to application stage. Hence it is high time to search for natural dyes and testing their dyeing ability for cotton fabrics. In the present study, the pigments present in flowers of *Caesalpinia pulcherima* were extracted by using four different solvent extraction schemes. Different mordants were used to fasten dye on cotton fabric. It resulted into four different color shades like red, pink, brown & lavender. Shades are having fastness to washing with hot water & soap too. The intensity of the above said colors are high and the dyes are eco friendly to the human skin.

### 1. Introduction

Due to the Global Environmental Awareness, trend of using natural color has been growing rapidly. Synthetic dyes pose the problem of environmental pollution during their synthesis to application and may show health hazard when applied on domestic fabrics. Synthetic dyes are not easily degradable. They get bioaccumulated in natural environment. In has been estimated that, nearly 10 lacks tons of synthetic dyes were used per annum<sup>1</sup>. Most of dyes are vegetable dyes and are extracted from roots, barks, leaves, flowers and berries etc. The discovery of many synthetic dyes followed quickly and flooded in the markets of Europe, Japan, Egypt and other countries; however was seem to be originally depended on Indian dyes isolated from natural sources, says Gahlot and Knur (1996). Many natural dyes required the use of chemical called mordents to bind the dye to the textile fibre. Tannin from Oak galls, salt, natural alum, vinegar, ammonia were used by early dyers<sup>2</sup>.

*Caesalpinia pulcherima* is a species of flowering plant in the pea family, Fabaceae that is native to the tropics and subtropics of the Americas. It could be native to the West India but its exact origin is unknown due to widespread cultivation. It is a shrub growing about 3 m tall. In climates with little to no frosts, this plant will grow larger and is semi-evergreen freezing; plant will die back to the ground depending on cold, but will re-bound in mid to late spring. This species is more sensitive to cold than others; the leaves are bipinnate, 20-40 cm long, bearing 3-10 pairs of pinnae, each with 6-10 pairs of leaflets 15-25 mm long and 10-15 mm broad. The flowers are borne in racemes up to 20 cm long, each flower with five yellow, orange or red petals. The fruit is a 6-12 cm long. *Caesalpinia pulcherima* are common flowers in India Figure 1<sup>3</sup>. The flower themselves are edible. In the present study, an attempt has been made to isolate natural dyes.



Figure 1: Plant of *Caesalpinia pulcherima*

### 2. Materials

#### 2.1 Plant Material

Fresh red color flowers of *Caesalpinia pulcherima* were collected in polythene bags from local area of Sangamner (District- Ahmednager, Maharashtra, India).

**2.2 Substrate:** The 100% soft cotton fabric was used as substrate.

#### 2.3 Chemicals

2% solutions of Alum ( $K_2SO_4 \cdot Al_2(SO_4)_3 \cdot 24H_2O$ ), Copper sulphate ( $CuSO_4 \cdot 5H_2O$ ), Ferrous sulphate ( $FeSO_4 \cdot 7H_2O$ ), Stannus chloride ( $SnCl_2$ ) are used as Mordents and 95% Ethanol was used as solvent.

### 3. Methods

#### 3.1 Extraction of dye from flower

Extraction of color dye was done by following four different methods.

##### 1. Aqueous Extraction Method

5 gm of fresh red color flowers of *Caesalpinia pulcherima* were boiled in 100 ml distilled water at 80°C for 30 minutes. The filtrate is used for further study.

##### 2. Acidic Extraction Method

In acidic extraction method, 5 gm of fresh red color flowers of *Caesalpinia pulcherima* were treated with 100 ml 1% Hydrochloric acid solution and boiled at 80°C for 30 minutes. The filtrate is used for further study.

##### 3. Alkaline Extraction Method

5 gm of fresh red color flowers of *Caesalpinia pulcherima* were boiled in 100 ml 1% Sodium hydroxide at 80°C for 30 minutes. The filtrate is used for further study.

##### 4. Alcoholic Extraction Method

5 gm of fresh red color flowers of *Caesalpinia pulcherima* were boiled in 50% Ethanol for 30 minutes in water bath. Finally the filtrate is used for further study.

#### 3.2 Exhausting of cotton cloth

Cotton cloth used for dyeing were boiled in 10% NaOH solution for 20 minutes to remove starch and impurities in the cloths and then thoroughly washed with cold water.

#### 3.3 Mordenting and Dyeing

Rectangular pieces of cotton cloth measuring 3 cm x 2 cm were treated with 25 ml 2% solutions of different mordents namely Alum,  $CuSO_4$ ,  $FeSO_4$  and  $SnCl_2$  for 30 minutes. Then the above said pieces are allowed to drain and immediately soaked in different extracts.

### 3.4 Color Fastness to Washing<sup>2,10</sup>

Color fastness to washing is the ability to retain its color after washing. The rating of 1 to 5 was adopted to define fastness for I to V washing respectively Table-1.

**Table 1. Result for the method of extraction.**

Mordent Method	Alum	CuSO <sub>4</sub>	SnCl <sub>2</sub>	FeSO <sub>4</sub>
Aqueous extraction	Lavender (III)	Gray (I)	Brown (III)	Pink (III)
Acidic extraction	Light pink (II)	Light pink (II)	Brownish Pink (IV)	Dark Pink (IV)
Alkaline extraction	Light Brown (III)	Brown (III)	Brown (IV)	Brown (III)
Alcoholic Extraction	Lavender (IV)	Pink (II)	Brown (III)	Red (IV)

(-) - Indicates fastness to washing in the rating scale I to V

### 4. Results and Discussion

Different color shades were observed from various extracts of *Caesalpinia pulcherima* red color flowers and the color intensities are showcased in Figure 2. The present work successfully produced the pink, red, brown and lavender color shades. The color strength also depends upon use of mordent<sup>11</sup>. Mordents are the metal salts having tendency to coordinate with dye and fibre<sup>12</sup>. The aqueous extract gave the light pink, gray, brown and lavender color shades with mordent such Alum, CuSO<sub>4</sub>, SnCl<sub>2</sub> and FeSO<sub>4</sub> respectively. The various pink shades on cotton fabrics were obtained using acidic extract with Alum, CuSO<sub>4</sub>, SnCl<sub>2</sub> and FeSO<sub>4</sub>. The alkaline extract with Alum, CuSO<sub>4</sub>, SnCl<sub>2</sub> and FeSO<sub>4</sub> give brown color shades respectively. While the alcoholic extract gave red, brown color shades in combination with mordents such as Alum, CuSO<sub>4</sub>, SnCl<sub>2</sub> and FeSO<sub>4</sub> respectively. The study revealed that the production of various natural color shades is possible from plant pigments. The present work suggests that utilization of flowers waste for isolation of natural colour is an example of value addition to waste leading to an impact on the economic growth of the rural communities. The aqueous extract is also used as food colour for colouring Nuddles as the flowers are edible. This work is also helpful for small scale dyeing and printing industries in locality.



Figure 2. Colour shades obtained on cotton fibres mordented with Alum (1), Copper sulphate (2), Stannous chloride (3) and Ferosulphate (4) using different extracts- Aqueous (A), Acidic (B), Alkaline (C) and Alcoholic (D)

### 5. Conclusion

The natural dyes extracted from red flowers of *Caesalpinia pulcherima* are safe because these are non-toxic and biodegradable in nature. Thus results obtained from the present investigation rebuild that the extracts of flowers of *Caesalpinia pulcherima* show four different color shades like pink, red, lavender and brown on cotton in presence of mordents like Alum (K<sub>2</sub>SO<sub>4</sub>.Al<sub>2</sub>SO<sub>4</sub>.24H<sub>2</sub>O), Copper sulphate (CuSO<sub>4</sub>.5H<sub>2</sub>O), Ferrous sulphate (FeSO<sub>4</sub>.7H<sub>2</sub>O.), Stannus chloride (SnCl<sub>2</sub>) with good fastness property to washing.

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