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## *Mirabilis jalapa* Linn. Flowers, a potential source of natural dye for cotton

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**Abstract**

The present study is an attempt on dyeing of cotton fibers using natural dye from the flowers of *Mirabilis jalapa* Linn. Dyeing of cotton with and without the use of mordant, pre-mordanting and at different pH was tested. The pre-mordanting was carried out with four selected mordants such as Potassium dichromate, ferrous sulphate, Copper sulphate, Tannic acid and their combinations. Different colour shades were obtained with respect to mordants. The dyeing results in shades of brown, black, yellow and green colour. Colour intensity depends on the type of mordants and pH. Ferrous sulphate and Tannic acid imparts darker shades. When the pH of dye bath increases the colour intensifies. pH 8 gave more better colour shades than pH 4. Among the combinations of mordants, ferrous sulphate and Tannic acid was found to be more suitable for better dyeing output.

**Keywords:** Natural dye, *Mirabilis jalapa* L., flowers, Natural dye, Mordants

**Introduction**

In human civilization plants are used not only for the basic needs of life such as food, fiber, cloths and shelter but also as sources of natural dyes for dyeing cloths, design and painting. A spectrum of beautiful natural colours ranging from yellow to black exists in the above sources. Colours in flowers are an adaptation that attract insects and other animals that in turn pollinate and helps the plants reproduce [1]. These colours are exhibited by various organic and inorganic molecules and their mixture is due to the absorption of light in the visible region of 400-800 nm [2]. Natural dyeing had developed essentially as a folk art. However in recent times the dyeing technique is interpreted on sound scientific principles and the interaction between the dye and the dyed material is well understood. Natural dyes find use in the colouring of textiles, drugs, cosmetics, etc. Owing to their nontoxic effects, they are also used for colouring various food products. Nature has gifted us with more than 500 dye yielding plant species. In India, there are more than 450 plants that can yield dyes [3].

Man has always been interested in colours, the art of dyeing has a long past and many of these dyes go back into prehistory. Dyeing might be an accidental happening but the need of dyeing become very common in human life. So art of dyeing spread widely as civilization advanced. Today dyeing is a complex and specialized science. Dyes are mainly classified into two types, natural dyes and synthetic dyes. Natural dyes obtained from plants, animals and minerals [4]. Almost all parts of the plants like root, bark, leaf, fruit, wood, seed, flower, etc. produce dyes. Unlike synthetic dyes which have been found to be toxic and harmful to environment, natural dyes are biodegradable, non-toxic, non-allergic to human health, easily available, more economical and generally have higher compatibility with environment [5]. Synthetic dyes are derived from non-renewable coal tar and petroleum. Some synthetic dyes are too toxic, when inhaled, absorbed through the skin or ingested [6].

Natural dyes require a mordant to fix to the fabric and prevent the color from either fading with exposure to light or washing out. These compounds bind the natural dye to the fabric. A mordant is an element which aids the chemical reaction that take place between the dye and the fiber, so that, the dye is absorbed [7]. Mordanting is the treatment of textile fabric with

the metallic salt or other complex forming agent which bind natural mordantable dyes onto textile fiber [8]. Mordanting is usually done in three methods; they are pre-mordanting, simultaneous mordanting and post mordanting [9]. Mordants come from primarily two groups-plant based, especially plants high in tannins and mineral based such as alum, iron, tin and chrome. Generally used mordants for dyeing cotton are like potassium dichromate, ferrous sulphate, copper sulphate and tannic acid, which have been used for mordanting [10]. Mordants should not affect the physical characteristics of the fibers. Sufficient time should be allowed for the mordant to thoroughly penetrate the fiber [11]. If the mordant is only superficial, the dye will be uneven: it will fade and will not be as brilliant as it should be. The brilliancy and fastness of natural dyes are probably due to a great extent to the length of time taken over the various processes of dyeing. The longer time that can be given to each process, the more satisfactory the result [12].

### Description of the selected plant

**Class:** Dicotyledons

**Sub-Class:** Monoclamydeae

**Order:** Caryophyllales

**Family:** Nyctaginaceae

**Genus:** *Mirabilis*

**Species:** *Mirabilis jalapa* L., Sp. Pl. 177. 1753 (Nyctaginaceae)

(Bentham & Hooker System of Classification)

Herbs with large tuberous roots; stem semisucculent. Leaves opposite, 3-9 x 2.5-5 cm, triangular-ovate, base obliquely truncate to shortly decurrent, apex acute to acuminate; lateral nerves 5-7 pairs; petiole to 3.5 cm long. Inflorescence of 3-7-flowered, terminal, capitate cluster. Perianth pink, white or yellow, funnel-shaped; tube to 4 cm long, slender, limb 5-lobed. Stamens 3-6, exserted. Ovary globose, sessile; stigma shortly lobed or fimbriate. Anthocarp 4-6 mm across, globose, rugose, black when ripe.

**Habit:** Herb

**Habitat:** Grown as garden plant and also found as escape.

**Fl. & Fr.:** Aug. – Apl.

**Distribution:** Native in Peru; now cultivated in all Tropical regions.



**Fig.1:** Image of *Mirabilis jalapa* L.

### Materials and methods

Dried flowers of *Mirabilis jalapa* Linn. is used as source for natural dye. 5×5 cm destarched cotton fabric is used for dyeing. The mordants used for the study are Potassium dichromate ( $K_2Cr_2O_7$ ), ferrous sulphate ( $FeSO_4$ ), Copper sulphate ( $CuSO_4$ ), Tannic acids ( $C_{76}H_{52}O_{46}$ )

### Extraction of dyes

Crude extract from the dried flowers of *Mirabilis jalapa* Linn. were prepared by adding 15 gm dry powdered material to 200 ml distilled water. The mixture was stirred, heated and maintained and boiled for 1 hour at 40°C and followed by filtering of the solution using Whatman filter paper No.1.

### Dyeing process

Dyeing of cotton fabrics was carried out by dyeing of cotton without the use of mordant, pre-mordanting and changing the pH of the dye bath used.

### Dyeing of cotton without mordant

The destarched cotton fabric were immersed in 50 mL dye bath solution and boiled for one hour. After boiling the fabric was left in the dye bath for 24 hours. After 24 hours the fabric was removed from the dye bath solution and squeezed to remove the moisture and dry.

### Pre-mordanting

0.5g mordants were weighed out and dissolved in 50 mL distilled water. The destarched cotton were immersed in 50 mL mordant solution and boiled for one hour. After boiling, the fabric was kept in the mordant bath. After 24 hours the fabric was removed from mordant bath and squeezed to remove moisture and left in cool place until ready to dye. All mordants used in this experiment were prepared by above mentioned procedure.

### Dyeing

The mordant cloth pieces were immersed in 50 mL dye bath and boiled for one hour. After boiling the fabric was kept in dye bath for 24 hours. Then removed the cloth pieces from dye bath and allowed them to dry. After drying, the cloth pieces were washed in distilled water and dried.

### Effect of pH on dyeing

The pH of the dye bath was adjusted to 4 and 8, by the addition of acid or alkali (1N HCl or 1N NaOH). Boil the mordanted cotton pieces in 50 mL dye bath solution of different pH such as 4 and 8 for one hour. After that the cloth were removed from the dye bath. Kept them undisturbed for some time. After drying the cloths were washed with distilled water and again dry them. The dyed cotton fabrics were washed thoroughly using tap water. The washing is continued till no more colour is coming from the dyed materials.

### Result & Discussion

The present study was done with an objective to dye cotton fabric using the natural dye obtained from *Mirabilis jalapa* Linn. Flowers using different mordants. A dye can be described as coloured substance that has an affinity to the substrate to which it is being applied. The dye is generally applied in an aqueous solution. Most of the natural dyes need a mordant for enhancement of their fastness properties. They had affinity for the dye and the cotton fibre resulting to strong complexes with the dye inside the fibre matrix. The shades of colour developed on the cotton fabrics after dyeing process with the crude dye solution are shown in the Figure 3-8. The crude dye solution was extracted by boiling the dried, powdered flowers (15g) in

200 ml distilled water. The depth of dyeing can be improved by using different metal salt mordants and combinations of these mordants and the pH plays in colour characterization of naturally dyed fabric materials. Mordants play an important role in imparting colour to the cotton fabric. Better colour strength results are dependent on the metal salt used. The different types of mordant and method of mordanting significantly affect the rate and extend of photo fading [13]. When changing the PH of the dye bath, as the pH increases the colour also increases. The present study investigate the dyeing of cotton material with

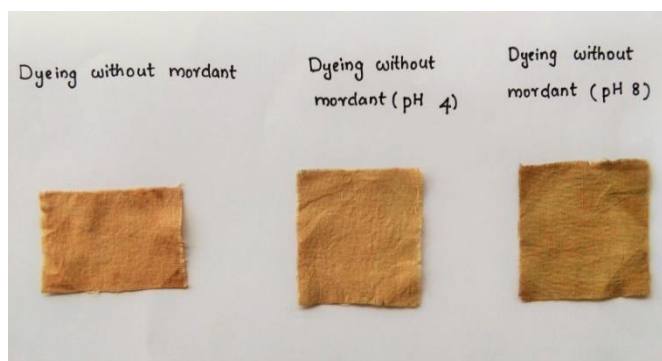
dye bath of pH 4 and pH 8. It is found that at pH 8 (alkaline pH) gave better colour shades than pH 4 (acidic pH).

**Dyeing of cotton without the use of mordants**

The dyeing of cotton without mordant gives different colour shades such as Pale Khaki, Khaki and Pale brownish Khaki. When cotton is dyed with crude dye solution only yield Pale brownish Khaki colour, at different pH such as pH 4 and pH 8, yield Pale Khaki and Khaki respectively. When pH increases results in the increases of colour also (Table 1 & 2).

**Table 1:** Dyeing of cotton without mordant by using crude dye extract from *Mirabilis jalapa* Linn. Flowers

Volume of dye bath in mL	Boiling time in minutes	Condition of dye bath	Colour of cloth developed
50 mL	60 minutes	pH 4	Pale Khaki
		pH 8	Khaki
		Pre-mordanting	Palebrownish Khaki



**Fig. 2:** Dyeing of cotton without mordant by using crude dye solution of *Mirabilis jalapa* Linn. Flowers

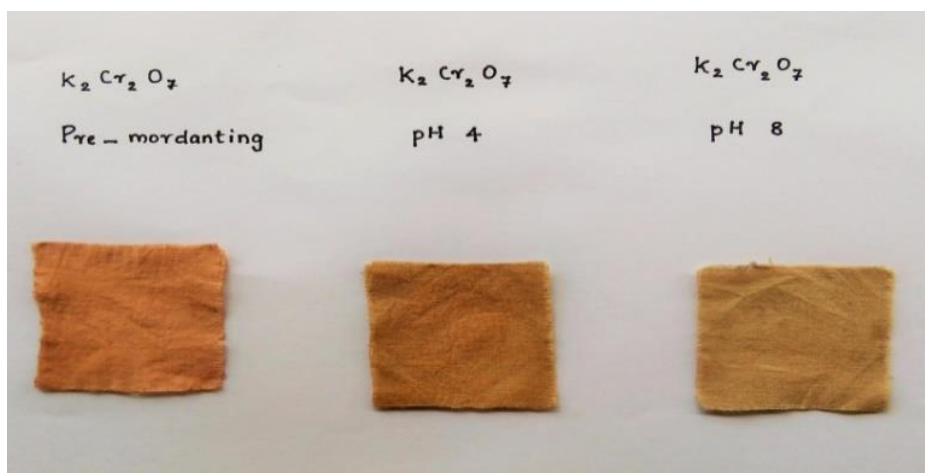
**Dyeing of cotton with the use of mordant [Potassium dichromate (K<sub>2</sub>Cr<sub>2</sub>O<sub>7</sub>)]**

When the cotton is pre- mordanted with Potassium dichromate yield Light golden brown colour. At different

pH such as pH 4 and pH 8, yield Light brownish Khaki and Khaki respectively. There is an increase in colour when the pH increases (Table 2 & 3)

**Table 2:** Dyeing of cotton with mordant [Potassium dichromate (K<sub>2</sub>Cr<sub>2</sub>O<sub>7</sub>)] by using crude dye solution of *Mirabilis jalapa* Linn. Flowers

Volume of dye bath in mL	Boiling time in minutes	Condition of dye bath	Colour of cloth developed
50 mL	60 minutes	pH 4	Light brownish Khaki
		pH 8	Khaki
		Pre-mordanting	Light golden brown



**Fig. 3:** Dyeing of cotton with mordant [Potassium dichromate (K<sub>2</sub>Cr<sub>2</sub>O<sub>7</sub>)] by using crude dye solution of *Mirabilis jalapa* Linn. Flowers

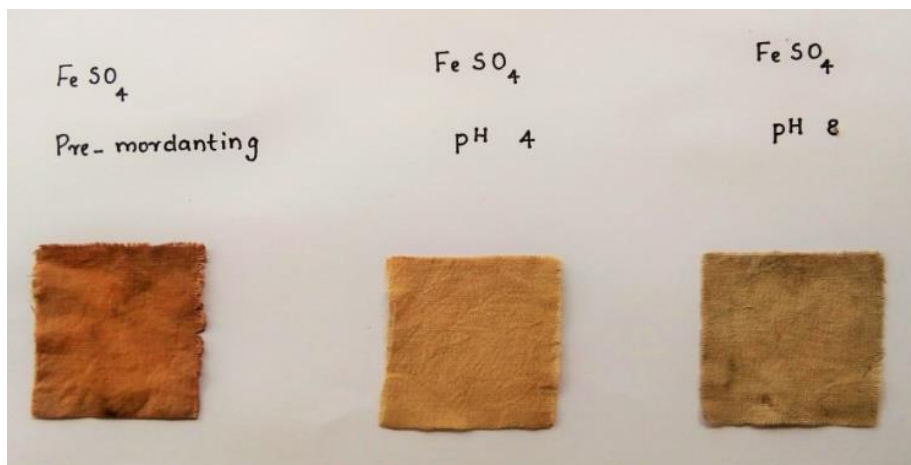
**Dyeing of cotton with the use of mordant [Ferrous sulphate (FeSO<sub>4</sub>)]**

When the cotton is pre-mordanted with ferrous sulphate yield Reddish brown colour. At different pH such as pH 4

and pH 8, yield Light Khaki and Light greenish Khaki respectively. There is an increase in colour when the pH increases (Table 3& 4).

**Table 3:** Dyeing of cotton with mordant [Ferrous sulphate ( $\text{Fe SO}_4$ )] by using crude dye solution of *Mirabilis jalapa* Linn. Flowers

Volume of dye bath in mL	Boiling time in minutes	Condition of dye bath	Colour of cloth developed
50 mL	60 minutes	pH 4	Light Khaki
		pH 8	Lightgreenish Khaki
		Pre-mordanting	Reddish brown



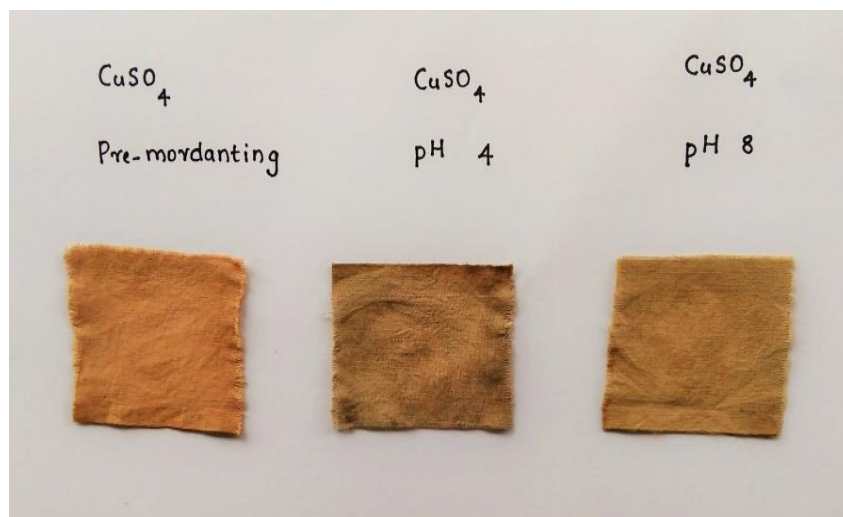
**Fig. 4:** Dyeing of cotton with mordant [Ferrous sulphate ( $\text{Fe SO}_4$ )] by using crude dye solution of *Mirabilis jalapa* Linn. Flowers

**Dyeing of cotton with the use of mordant [Copper sulphate ( $\text{Cu SO}_4$ )]**  
 When the cotton is pre- mordanted with Copper sulphate yield Pale golden brown colour. At different pH such as pH

4 and pH 8, yield Olive greenish Khaki and Pale greenish Khaki respectively. There is an increase in colour when the pH increases (Table 4& 5)

**Table 4:** Dyeing of cotton with mordant [Copper sulphate ( $\text{Cu SO}_4$ )] by using crude dye solution of *Mirabilis jalapa* Linn. Flowers

Volume of dye bath in mL	Boiling time in minutes	Condition of dye bath	Colour of cloth developed
50 mL	60 minutes	pH 4	Olivegreenish Khaki
		pH 8	Palegreenish Khaki
		Pre-mordanting	Pale golden brown



**Fig. 5:** Dyeing of cotton with mordant [Copper sulphate ( $\text{Cu SO}_4$ )] by using crude dye solution of *Mirabilis jalapa* Linn. Flowers

**Dyeing of cotton with the use of mordant [Tannic acid ( $\text{C}_76 \text{H}_{52} \text{O}_{46}$ )]**  
 When the cotton is pre-mordanted with Tannic acid yield Light golden brown colour. At different pH such as pH 4

and pH 8, yield Dark Khaki and Golden brown colour respectively. There is an increase in colour when the pH increases (Table 5& 6).

**Table 5:** Dyeing of cotton with mordant [Tannic acid ( $\text{C}_76 \text{H}_{52} \text{O}_{46}$ )] by using crude dye solution of *Mirabilis jalapa* Linn. Flowers

Volume of dye bath in mL	Boiling time in minutes	Condition of dye bath	Colour of cloth developed
50 mL	60 minutes	pH 4	Dark Khaki
		pH 8	Golden brown
		Pre-mordanting	Lightgolden brown

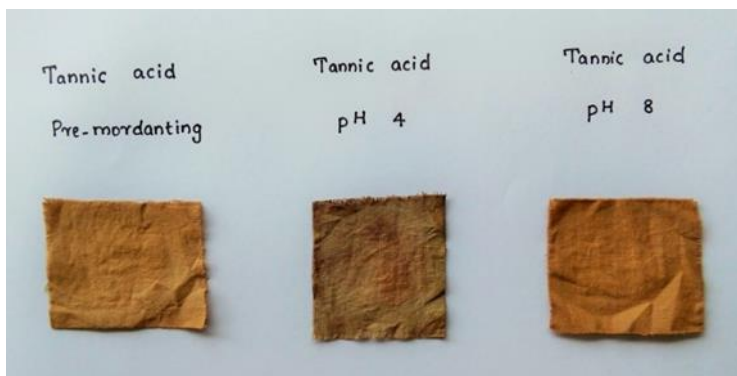


Fig. 6: Dyeing of cotton with mordant [Tannic acid ( $C_{76}H_{52}O_{46}$ )] by using crude dye solution of *Mirabilis jalapa* Linn. Flowers

**Dyeing of cotton with the use of combinations of mordants**

The combinations of mordants for dyeing of cotton gives different colour shades such as Pale brownish Khaki, Dark golden brown, Dark brown, Dark Olive green, Dark Khaki and Black. The combinations of mordants used were Copper sulphate and Potassium dichromate, ferrous sulphate and Copper sulphate, Potassium dichromate and Ferrous sulphate, Tannic acid and Copper sulphate, Tannic acid and Ferrous sulphate, and Tannic acid and Potassium dichromate. When the cotton is pre-mordanted with combination of Ferrous sulphate and Copper sulphate yield Dark brown colour, with Potassium dichromate and Ferrous sulphate yield Dark olive green, with Copper sulphate and

Potassium dichromate yield Dark golden brown, with Tannic acid and Potassium dichromate yield Pale brownish Khaki, with Ferrous sulphate and Tannic acid yield Black, and with Tannic acid and Copper sulphate yield Dark Khaki (Table 6 & 7).

In this study, combinations of mordants were also used for dyeing of cotton. Using of combinations of mordants was found to be more effective than using of single mordants. Among the combinations of mordants used here, combinations of Ferrous sulphate and Tannic acid is found to be more suitable combination of mordants than others studied as it gave more colour intensity.

Table 6: Dyeing of cotton with the use of combinations of mordants by using crude dye solution of *Mirabilis jalapa* Linn. Flowers.

Volume of dye bath in mL	Boiling time in minutes	Combinations of mordants used	Colour of cloth developed
50 mL	60 minutes	$C_{76}H_{52}O_{46} + CuSO_4$	Dark Khaki
		$FeSO_4 + C_{76}H_{52}O_{46}$	Black
		$K_2Cr_2O_7 + C_{76}H_{52}O_{46}$	Pale brownish Khaki
		$CuSO_4 + K_2Cr_2O_7$	Dark golden brown
		$K_2Cr_2O_7 + FeSO_4$	Dark Olive green
		$FeSO_4 + CuSO_4$	Dark brown

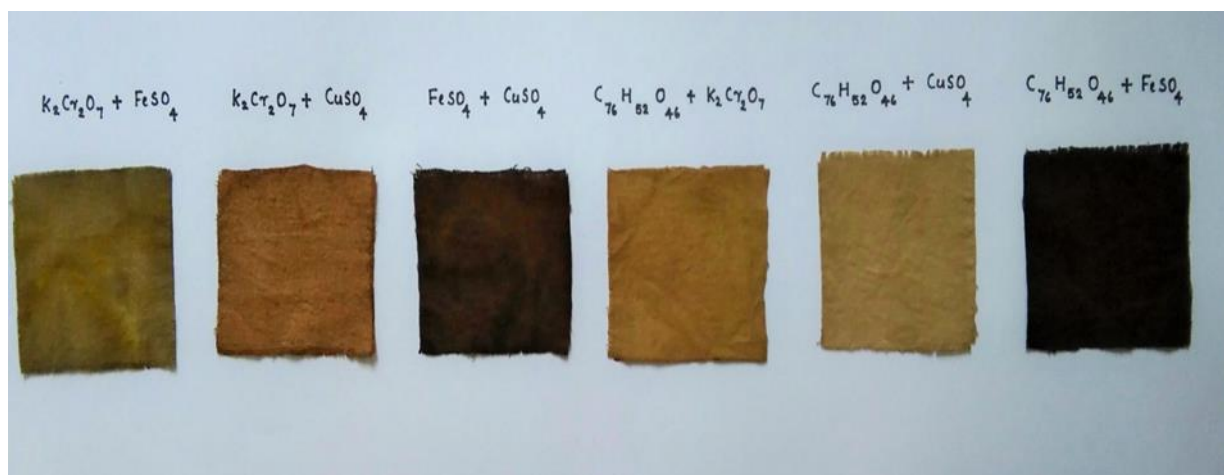


Fig.7: Dyeing of cotton with the use of combinations of mordants

**Conclusion**

The present study highlighted the potential of natural dye obtained from the flowers of *Mirabilis jalapa* Linn. and its affinity to cotton fibers. The mordants used for the dyeing process were Potassium dichromate, ferrous sulphate, Copper sulphate, Tannic acid and its combinations. The effect of pH on dyeing was also evaluated. Cotton cloth pieces were used for the evaluation. The scope of natural dyeing used the flowers of *Mirabilis jalapa* Linn. dye for

obtaining various colours is immense. It is cost effective and eco-friendly. Process optimization of extraction and natural dyeing using the flowers of *Mirabilis jalapa* Linn. is recommended before commercialization.

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