



Application of natural dye extracted from floral parts of *Mirabilis jalapa* linn. flowers

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Abstract

Now a days, synthetic dyes became serious health hazard as it releases vast amount of waste and unfixed colorants and are troubling the eco-balance of the nature. Due to environmental matters in the production besides application of synthetic dyes, now-a-days consumers interest in natural dyes ones again revived. The present study expresses dyeing of cotton cloth using natural dye obtained from the floral parts of *Mirabilis jalapa* Linn. Pre-mordanting, application of dye to cotton with and without using mordant as well as at different pH was tried. The pre-mordanting was performed by using four chosen mordants i.e., Ferrous sulphate, Potassium dichromate, Copper sulphate, Tannic acid and their combinations. Separate mordants and their blends showed different colour shades. The dyeing developed various shades of brown, black, khaki and pink colour. The colour developed and their intensity depends on the type of mordants and respective pH conditions. Among them Ferrous sulphate and Tannic acid impart darker shades. As the pH of dye bath increases, the colour intensifies and the pH 8 offered improved colour shades as compared to pH 4. Ferrous sulphate and Tannic acid were found to be more suitable among the used mordants, as they exhibited better dyeing output.

Keywords: natural dye, flowers, *Mirabilis jalapa* linn, colour, mordants

Introduction

From history plants are proved to be helpful not only for the basic requirements of existence such as food, shelter and cloths, but also as suppliers of natural dyes for the purpose of dyeing cloths, illustrating and painting. A broad range of beautiful spontaneous colours extending from lighter to darker shades occurs in the above sources. Natural dyes find their function in the colouring of fabrics, as colourants in drugs as well as cosmetics, etc. For the reason of their non-toxic effects, they also uncover application as colouring agent in various food products. Mother nature has empowered us with beyond 500 dye yielding plant species. In India, there are almost 450 plant species, from which dye can be gained [1-3].

There are two main categories of colorants, natural dyes and synthetic dyes. Natural dyes obtained from various plants as well as from animals and minerals. Almost each portion of the plants like flower, fruit, root, bark, seed, leaf, wood, etc. produce dyes. To colour the cloth various dyeing techniques are adopted such as sticking plant to fabric or rubbing crushed pigment into cloth or plant material were heated with the fabric. Natural dyes are non-allergic as well as non-toxic to human health, biodegradable, effortlessly obtainable, economical unlike synthetic dyes and generally have superior compatibility, and are harmless to environment. In comparison with natural dyes, certain synthetic dyes are too toxic and cause serious health issue when inhaled or absorbed over the skin or ingested [4-8].

Natural dyes can be utilized to colour most types of material or fibres. For the prevention of colour fading by exposure of light or rinsing out, natural dyes need a mordant to settle colour to the fabric. Mordants fix the natural dye to the textile [9-12]. A mordant is defined as a chemical which reinforces the chemical reaction that happen between the dye and the fibre, to increase absorption of dye. Mordanting is the reaction of textile material with the metallic salt creating agent which fix natural dyes onto textile material. There are three methods for mordanting; premordanting, simultaneous mordanting and post mordanting. Potassium dichromate, ferrous sulphate, copper sulphate and tannic acid are generally used mordants for dyeing cotton. Sufficient time is required for the mordant to thoroughly penetrate the fibre. The dye will be uneven, if the mordanting is only superficial, as a result it will either fade or won't be as deep as it should be. The fastness and intensity of natural dyes are conceivably due to the time period taken over the several steps of dyeing. More satisfactory results will be obtained by spending longer time on each process. Recently, extensive research work is being carried out around the world on use of natural dyes as textile colorants. An attempt has been made in this research work, to apply natural dye (*Mirabilis jalapa*) on cotton fabric [13, 14].

Materials and Methods

▪ *Mirabilis jalapa* flower selected for dyeing

Freshly collected *Mirabilis jalapa* flower (Fig. 1) used for dyeing cotton fabric. A curious aspect about this plant is that different colour variation in the flower and different coloured flowers found on the same plant. Additional interesting fact is a colour-changing phenomenon i.e., as plant matures colour of flower changes. For example, in the yellow-coloured variety, as the plant matures, it can change its colour gradually to pink. ^[15]



Fig 1: Image of *Mirabilis jalapa* L.

▪ *Textile material*

Commercially available cotton fabrics were selected for this experiment.

▪ *Mordants*

Synthetic and natural mordanting material was used with dye. Premordanting is done using four selected mordants (Table 1) and their combinations.

Table 1: Mordants used for dyeing cotton fabric

Sr. No.	Name	Molecular Formula
1	Potassium dichromate	$K_2Cr_2O_7$
2	Copper sulphate	$CuSO_4$
3	Ferrous sulphate	$FeSO_4$
4	Tannic acid	$C_{76}H_{52}O_{46}$

Methods

▪ *Extraction of dyes*

Dye from *Mirabilis jalapa* flowers was extracted separately from flower by aqueous extraction in the proportion of 1:2. The extraction process is carried out at 80- 85 °C for 1 hour (Fig. 2). When the extraction procedure was completed, the flowers were removed from liquor and they were utilized for extraction for second time. Experimentally it was observed that the temperature range of 80°-90°C and time 1 hour, gives the better results, so this was the optimized time and temperature for extraction process. ^[16]



Fig 2: Extraction of dyes from *Mirabilis jalapa* Linn. flowers.

▪ **Dyeing process**

Dyeing of cotton fabrics was performed three stages: ^[17]

1. **Coloring of cotton with no mordant**

The cotton cloth was dipped in 100 ml dye solution and then boiled for 60 minutes. Afterwards, the cloth was left in the dye solution for 24 hours. Finally, after 24 hours the cloth was separated from the dye bath and squeezed to eliminate the moisture and dried.

2. **Pre-mordanting**

For pre-mordanting, 1 g mordants were weighed accurately and dissolved in 100 ml distilled water. Then, cotton was dipped in above 100 ml mordant solution and heated for one hour (Fig. 3). After boiling, the cloth was hold into the mordant bath for 24 hours. After 24 hours the cotton was taken out from mordant bath and squeezed to remove moisture and put in cool place until it becomes ready for dyeing. All mordants employed in this work were prepared by above said procedure.



Fig 3: Pre-Mordanting

3. **Dyeing**

The mordanted cloth fragments were immersed in 100 ml dye solution and heated for one hour. Later on, the fabric was hold into dye bath for 24 hours. Then the cloth fragments were removed from dye bath and permitted them to dry. After drying, the cloth fragments were washed in distilled water and finally dried.

▪ **Effect of pH on dyeing**

To study the 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). The mordanted cotton fragments were heated in 50 ml dye solution of two different pH such as 4 and 8 for one hour. After that, the cloth was separated from the dye bath and kept undisturbed for some time. Later, the cloth pieces were washed with distilled water and dried. The final dyed cotton cloths were washed thoroughly using tap water.

Results and Discussion

The current study was completed with an intention to dye cotton cloth using the natural dye obtained from flowers of *Mirabilis jalapa* Linn. using several mordants. The colour shades developed on the cotton cloth after dyeing with the crude dye solution were displayed in the Figure 4 and 5. The crude dye solution was prepared by extracting the fresh flowers in distilled water. By using different metal salt mordants and combinations of these mordants, the depth of dyeing can be enhanced, as well as the pH reliant colour characterization was performed. While studying the effect of change in pH it was observed that, as the pH increases the colour intensity also increases. In the current study, dyeing of cotton material at pH 4 and pH 8 was studied (Table 2). It was found that pH 8 (alkaline pH) offered better colour tints than pH 4 (acidic pH).

Table 2: Dyeing of cotton without and with the use of mordant by using crude dye extract from *Mirabilis jalapa* Linn. Flowers.

Sr. No.	Mordant used for dyeing	Colour of cloth developed at different conditions of dye bath		
		Pre-mordanting	pH 4	pH 8
1.	Dyeing without the use of mordant	Pale brownish khaki	Pale khaki	Khaki

2.	Potassium dichromate ($K_2Cr_2O_7$)	Light golden brown	Light brownish khaki	Khaki
3.	Copper sulphate ($CuSO_4$)	Light pink	Pale khaki	Pale golden brown
4.	Combination of $FeSO_4$, $CuSO_4$ and $K_2Cr_2O_7$	Brownish Yellow	Brownish Khaki	Pale Grey
5.	Combinations of $FeSO_4$, $CuSO_4$, and $C_7H_5O_4$	Gray Blue	Light blue	Brownish Khaki
6.	Combination of $CuSO_4$, $K_2Cr_2O_7$, and $C_7H_5O_4$	Yellowish brown	Faint bluish grey	Dark brownish black
7.	Combination of $FeSO_4$, $K_2Cr_2O_7$ and $C_7H_5O_4$	Yellowish Brown	Faint Reddish	Dark Golden Brown

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

The dyeing of cotton without mordant provides different colour shades such as Pale brownish khaki, Pale khaki and Khaki. When cotton cloth is dyed with crude dye solution, it showed Pale brownish khaki colour, at different pH such as pH 4 and pH 8, produced pale khaki and khaki colour respectively. Increase in pH resulted in increase in the colour intensity also.

▪ **Premordanting of cotton with Potassium dichromate ($K_2Cr_2O_7$)**

Dyeing of cotton cloth with Potassium dichromate produced different colour shades such as Light golden brown, light brownish khaki and Khaki. By pre-mordanting with Potassium dichromate, cotton cloth displayed Light golden-brown colour. At diverse pH condition such as pH 4 and pH 8, showed Light brownish Khaki and Khaki colour respectively. There is an increase in colour intensity as the pH increases.

▪ **Premordanting of cotton with Copper sulphate ($CuSO_4$)**

Light pink colour is obtained by pre-mordanting cotton with copper sulphate. Pale khaki and Pale golden brown colour was obtained at different pH conditions such as pH 4 and pH 8, respectively. There is an increase in colour as pH increases.



Fig 4: Colour shades produced by dyeing of cotton without and with mordant by using crude dye solution of *Mirabilis jalapa* Linn.

▪ **Premordanting of cotton with the use of combination of mordants**

In present study, for dyeing of cotton combination of mordants were also used. Use of mordants combinations for dyeing was found to be more effective than using single mordant as it gives more colour intensity than single mordant. The combinations of mordant gives different colour shades such as Brownish yellow, Pale grey, Brownish khaki, Grey blue, Light blue, Dark golden brown, Dark brown, Faint bluish grey, Faint reddish, Dark brownish Black. The mordants such as ferrous sulphate, Copper sulphate, Potassium dichromate and Tannic acid were used in combination for dyeing of cotton.

The combinations of mordant used were

1. Ferrous sulphate (FeSO_4), Copper sulphate (CuSO_4) and Potassium dichromate ($\text{K}_2\text{Cr}_2\text{O}_7$).
2. Ferrous sulphate (FeSO_4), Copper sulphate (CuSO_4) and Tannic acid ($\text{C}_{76}\text{H}_{52}\text{O}_{46}$).
3. Copper sulphate (CuSO_4), Potassium dichromate ($\text{K}_2\text{Cr}_2\text{O}_7$) and Tannic acid ($\text{C}_{76}\text{H}_{52}\text{O}_{46}$).
4. Ferrous sulphate (FeSO_4), Potassium dichromate ($\text{K}_2\text{Cr}_2\text{O}_7$) and Tannic acid ($\text{C}_{76}\text{H}_{52}\text{O}_{46}$).



Fig 5: Colour shades produced by *Premordanting* of cotton with the combination of mordants and dyeing with crude dye solution of *Mirabilis jalapa* Linn. flowers.

- *Premordanting of cotton with the combination of Ferrous sulphate (FeSO₄), Copper sulphate (CuSO₄) and Potassium dichromate (K₂Cr₂O₇).*

When the cotton is premordanted with combination of Ferrous sulphate, Copper sulphate and Potassium dichromate it showed Brownish yellow colour. At pH 4 and pH 8, Brownish Khaki and Pale grey colour observed respectively. There is decrease in colour as pH increases.

- *Premordanting of cotton with the combination of Ferrous sulphate (FeSO₄), Copper sulphate (CuSO₄) and Tannic acid (C₇₆H₅₂O₄₆)*

When the cotton is pre-mordanted with combination of Ferrous sulphate, Copper sulphate and Tannic acid, it showed Gray Blue colour. At different pH such, as pH 4 and pH 8, yield Light blue and Brownish khaki colour respectively. There is an increase in colour as pH increases.

- *Premordanting of cotton with the combination of Copper sulphate (CuSO₄), Potassium dichromate (K₂Cr₂O₇) and Tannic acid (C₇₆H₅₂O₄₆)*

When the cotton is pre-mordanted with combination of Copper sulphate, Potassium dichromate, and Tannic acid, it gives Yellowish Brown colour. At different pH, such as pH 4 and pH 8, showed Faint bluish grey and Dark brownish black colour respectively. There is an increase in colour as pH increases.

- *Premordanting of cotton with the combination of Ferrous sulphate (FeSO₄), Potassium dichromate (K₂Cr₂O₇) and Tannic acid (C₇₆H₅₂O₄₆).*

When the cotton is pre-mordanted with combination of Ferrous sulphate, Potassium dichromate and Tannic acid, it showed Yellowish brown colour. At different pH, such as pH 4 and pH 8, showed Faint reddish and Dark golden-brown colour respectively. There is an increase in colour when pH increases.

Conclusion

The current study emphasized the extraction of natural dye from the flowers of *Mirabilis jalapa* Linn. and its affinity to dye cotton cloths. Mordants were used to set the colour of dye. For the dyeing process Potassium dichromate, Ferrous sulphate, Copper sulphate, Tannic acid and their combinations were used. Cotton cloth was used for the dyeing. The effect of pH on dyeing was also evaluated by dyeing cotton at two different pH ranges, pH 4 and pH 8. The colour variation obtained by changing the pH of dye bath, as the pH increases the colour intensity also increases.

Consent for Publication

None

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Conflict of Interest

None

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