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Research Article

Extraction and Application of Natural Dye on Cotton and Jute Fabric

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Abstract

Natural dyes were used to color textile fabric from time immemorial. As the time advances, the utilization of synthetic dyes gained momentum. But the awareness to protect the environmental ecology & combat pollution, many synthetic colorants has been banned. As a result natural dyes and pigments are getting attention once again especially to dye fabric. Nature has gifted more than 500 dye yielding plant species and Calendula officinalis of family Calenduleae is one of them. It is commonly known as Indian Marigold. In this piece of work, authors have made an attempt to dye cotton & jute fabric by the Indian Marigold aqueous extract. Alum was chosen as a dye fixative or mordant.

Keywords: *Calendula officinalis*, Aqueous dye extract, Alum, Cotton fabric, Jute fabric, dyeing

Introduction

Natural dyes were used to color textile fabric from time immemorial. They not only impart color to the fabric but also occupy a vast space in Pharma Industry for their wide range of medicinal applications and therapeutic value. With the advent of time, synthetic colors gained attention and used widely in dyeing fabrics. Presently many synthetic colorants have been banned because of their allergy like symptoms and many are carcinogens [1]. Hence, to protect the environmental ecology & control pollution, natural dyes and pigments are getting attention. Natural dyes are now used in cosmetic industry due to nil side effects, UV ray protection and anti-aging properties [1]. India is rich in natural wealth & there are many scopes to explore & revive application of natural dyes on textiles. Nature has gifted more than 500 dye yielding plant species [2], one such much used dye yielding plant is Calendula officinalis of family Calenduleae commonly known as Indian Marigold. Marigolds are edible and widely cultivated in sub-continental region [3]. The Indian marigold possesses huge health benefits. It contains flavanoids which have strong anti-inflammatory properties. The carotenoids & triterpenoids prevent the body from free radicals & may suppress cell fusion and inhibit viral replication. It is used in controlling bleeding and soothing irritated tissue, bedsores, skin inflammation, acne, burns, radiation induced dermatitis, eczema, sunburn, rashes etc. It is also used in the treatment of cancer, ulcer, abdominal cramps, infections and many more [3]. In the present study, the authors have attempted to dye cotton & jute fabric from the Indian Marigold aqueous extract. Alum was chosen as a dye fixative chemical or mordant. It is widely used in industries for water purification. It also exhibit antiseptic, antispasmodic and astringent property. Mordant is a chemical which have a metal with a valency of at least two or more. Natural dyes do not readily adhere to cotton and jute fiber mordant is needed to fix wide range of soft and deep colors on fabrics. Mordant fix the dyes on fabrics forming a coordination complex with the dye which then attaches to the fabric [4].

Materials and Methods

Materials

A cloth of 100% cotton, Gossypium hirsutum of Malvaceae family and a jute cloth Corchorus olitorius of tiliaceae family were collected from local market. The yellow colored dye was extracted from the fresh floral parts of Indian Marigold, Calendula officinalis collected from local market, Agartala, Tripura West. Distilled water was prepared in our laboratory and used thereafter in this work. Alum was purchased from local market. Any other chemicals used were of analytical grade.

Extraction of Dye from Indian Marigold Flowers

The required quantity of fresh floral parts was weighed precisely (Figure 1). It was then taken in a beaker containing distilled water and stirred using a magnetic stirrer. The heater was turned on and the water was heated to a temperature range of 60-80 °C for 1 h. Dye was extracted by preparing an aqueous solution of flowers (5 gm in 50 ml distilled water). After 1 h the extraction process was stopped and the flowers were strained and the liquid extract was collected. A dark yellowish brown colored solution was obtained.

Preparation of Mordant Solution

Alum (Potassium Aluminum Sulfate) was used in this experiment as a mordant. The alum solution was prepared in the concentration range of 0.5 - 4% and the working concentrations are 0.5%, 1%, 2%, 3% and 4%. A stock solution of Alum was prepared which was then diluted with distilled water to achieve the aforesaid concentrations.

Dyeing Procedure

The extract obtained through above mentioned method was filtered and used for dyeing (Fig. 2). Cloth pieces (Cotton & Jute) that were used for dyeing was boiled in NaOH solution (10%) for 15 minutes to remove starch from the cloth. It was then washed with cold distilled water to remove any chemical substances. The cloths were then transferred into a mordant solution (Alum) for 20 minutes followed by treatment in the dye bath for predetermined period of time. The factor like time of immersion in dye bath effecting the dyeing was studied. The cloths were then studied for wash, light and rub fastness. The dyeing process has been represented here schematically in the flow chart given below.

Figure 1: Indian Marigold Flower

Cotton and Jute cloth (10 × 8 cm)
⇩
Cloth boiled in NaOH solution (10%) for 15 minutes
⇩
Washed with cold distilled water
⇩
Transferred in mordant (Alum) for 20 minutes
⇩
Treatment in the dye bath (prepared according to the methods explained in dye extraction) for predetermined period of time
⇩
Dried in Sunlight
⇩
Cloth with best result washed with Soap solution
⇩
Again dried in Sunlight for 2 hours
⇩
Evaluated for Color, Light and Wash fastness

Figure 2: Aqueous extract of yellow colored dye from Indian Marigold flower

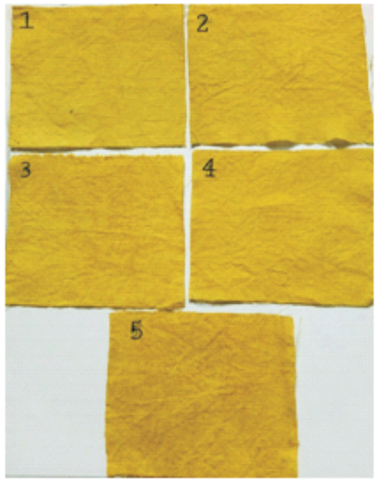

Figure 3: Dyeing of Cotton fabric after 60 minutes of exposure in dye bath (S_1)

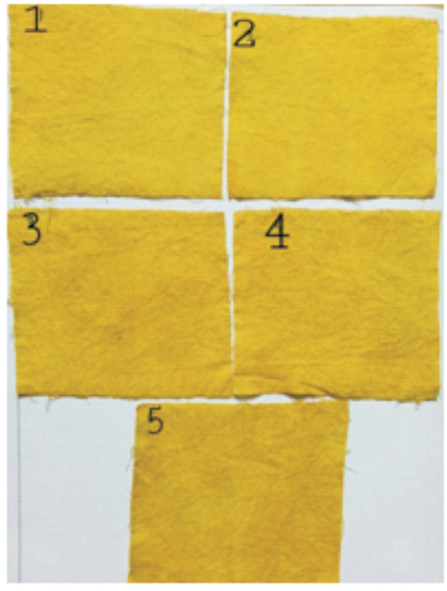

Figure 4: Dyeing of cotton fabric after 30 minutes of exposure in dye bath (S_2)

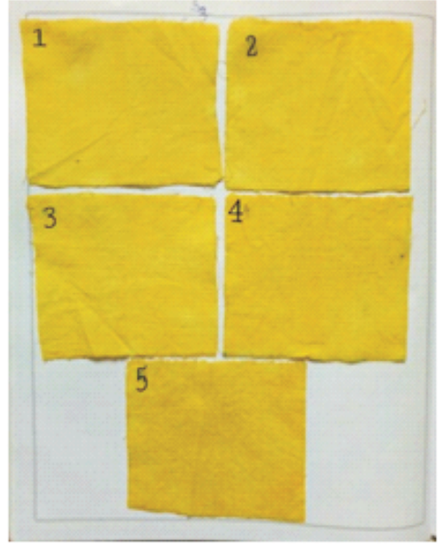

Figure 5: Dyeing of cotton fabric after 15 minutes of exposure in dye bat

Tests to Evaluate Dyeing Efficiency

Few tests were carried out to evaluate the efficiency of dyeing. These are wash fastness, rubbing fastness and light fastness test.

Wash fastness

This is a kind of test carried out to evaluate any changes in coloration right after washing with soap solution. The dyed cloth pieces were then subjected to washing in detergent solution. After washing the cloth pieces were dried in sun and color alteration were evaluated by visual inspection.

Rubbing fastness

This is a kind of test carried out to evaluate any changes in coloration right after rubbing between hand palms. Rub fastness measures the ability of the dyed fabrics to preserve the coloration during rubbing.

Light fastness

For this test, we put the detergent washed cloths in the sun comparing with indoor dried cloth.

Results and Discussion

Extraction of Dye from Indian Marigold Flowers

Aqueous extraction process was adopted and the flowers were strained after 1 h. The liquid extract was then collected. A dark yellow colored solution of 45 ml was obtained (Figure 2).

Preparation of Mordant Solution

Alum is used in this experiment as a mordant. The function of mordant is to fix the dye on the fabric surface by forming a coordinate bond between the dye molecule and the fabric. 40 ml of alum solution was prepared in the concentration range of 0.5 - 4% w/v, into which the cotton and jute cloth pieces were immersed for predetermined period of time.

Dyeing Procedure for cotton cloth

The cotton cloth piece of 10 x 8 cm was treated with the mordant (Alum) by immersing it into the mordant solution for a period of 20 minutes. Then the mordant treated cloth pieces were dried in the sun light and then immersed into the dye bath for a period of 15 minutes, 30 minutes and 60 minutes respectively. Different Parameters of Cotton Fabric Dyeing is presented in the (Table 1). The intensity of dyeing onto the white cotton cloth pieces are displayed in the (Figure 3, 4, 5). It was found that the intensity of dyeing was increased with increased time of bathing in the dye solution. Hence a desirable degree of coloration may be achieved by manipulating the time of immersing the cloth piece in the dye bath.

Table 1: Different Parameters of Cotton Fabric Dyeing

Size of Cotton Cloth Piece(cm)	Wt of Fresh Flower Petals (gm)	Volume of water taken (ml)	Volume of extract (ml)	Alum concentration (% w/v)	Time of immersion in alum (min)	Time of immersion in extract solution (min)
(10 x 8)	5	50	45	0.5, 1, 2, 3, 4	20	60 (S_1) 30 (S_2) 15 (S_3)

Dyeing Procedure for jute cloth

The jute cloth piece of 10 x 8 cm was treated with the mordant (Alum) solution for a period of 20 minutes. Then the mordant treated jute pieces were dried in the sun and later on immersed into the dye bath for a period of 60 minutes. Different Parameters of Jute Fabric Dyeing is presented in the (Table 2). The intensity of dyeing onto the white jute cloth pieces are displayed in the (Figure 6). It was found that the intensity of dyeing was increased with increased time of bathing in the dye solution. Hence a desirable degree of coloration may be achieved by manipulating the time of immersing the cloth piece in the dye bath.

Table 2: Different Parameters of Jute Fabric Dyeing

Size of Jute Cloth Piece(cm)	Wt of Fresh Flower Petals (gm)	Volume of water taken (ml)	Volume of extract (ml)	Alum concentration (% w/v)	Time of immersion in alum (min)	Time of immersion in extract solution (min)
(10 x 8)	5	50	45	0.5, 1, 2, 3, 4	20	60 (S_4)

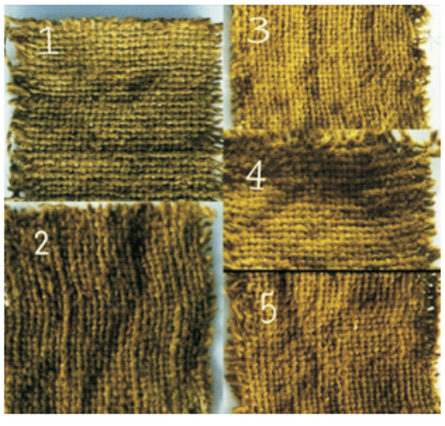

Figure 6: Dyeing of Cotton fabric after 60 minutes (S4)

Tests to Evaluate Dyeing Efficiency

The below tests were carried out to evaluate the efficiency of dyeing on cotton fabric. These are wash fastness, rubbing fastness and light fastness.

Wash fastness for cotton fabric

5th no. cotton cloth piece of S1 was chosen for the evaluation purpose as this piece of cloth was in contact with dye bath for the highest 60 minutes. A 4% of mordant concentration was used for this purpose. From this test it was observed that there are certain changes in the coloration right after washing with soap solution. It was found that the dyed cotton cloth pieces were faded to a certain extent after subjecting to washing in detergent solution. The coloration of cotton fabric after dyeing and after washing is displayed in the (Figure7).

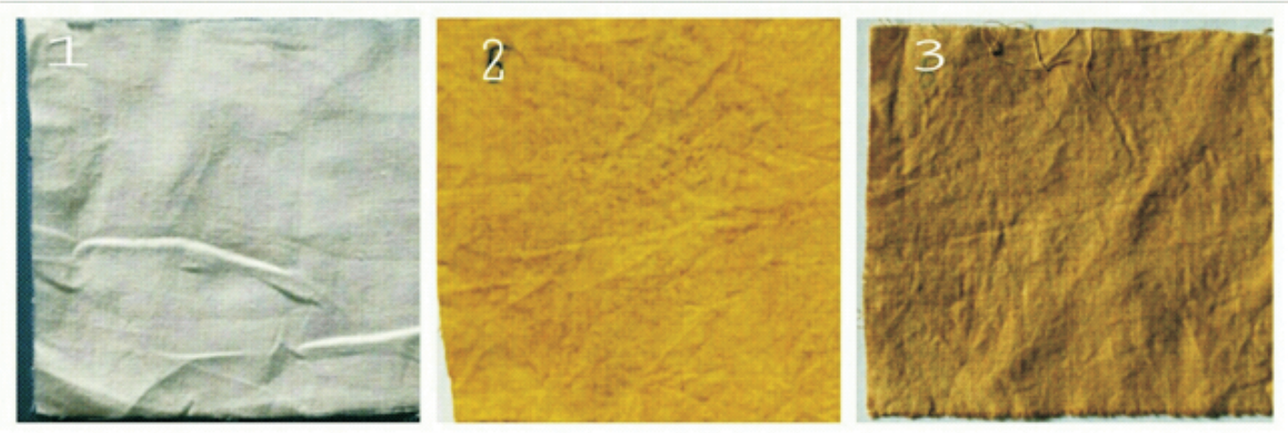

Figure 7: Coloration of Cotton Fabric after Dyeing & after Washing **(1)** before dyeing **(2)** after dyeing **(3)** after washing

Wash fastness for jute fabric

5th no. jute cloth piece of S4 was chosen for the evaluation purpose as this piece of cloth was in contact with dye bath for the highest 60 minutes. A 4% of mordant concentration was used for this purpose. From this test it was observed that there are certain changes in the coloration right after washing with soap solution. It was found that the dyed jute cloth pieces were faded to a certain extent after subjecting to washing in detergent solution. The coloration of jute fabric after dyeing and after washing is displayed in the (Figure 8).

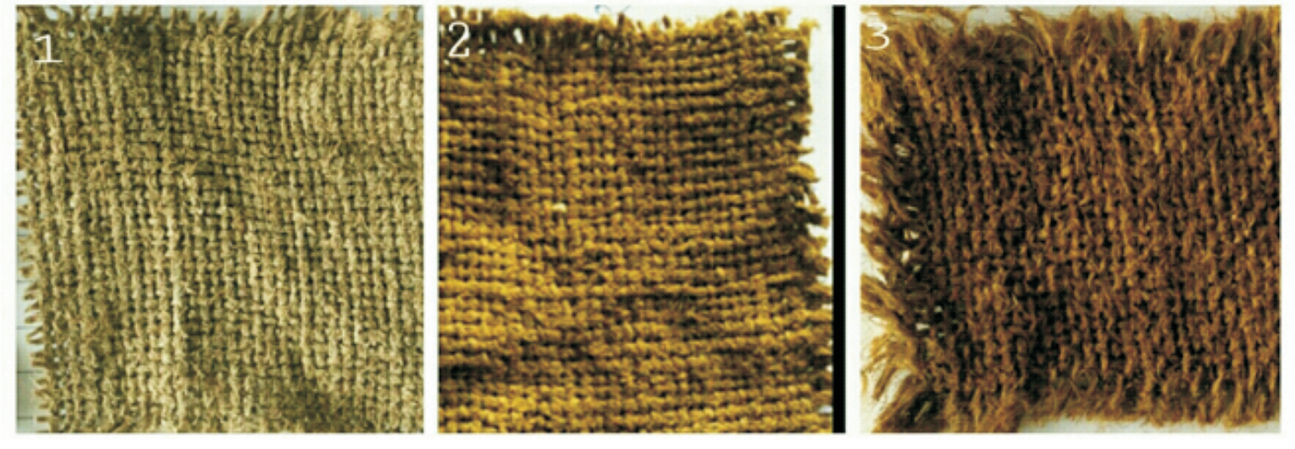

Figure 8: Coloration of jute fabric after dyeing & after washing

Rubbing fastness for cotton and jute fabric

This is a kind of test carried out to evaluate any changes in coloration right after rubbing between hand palms. Rub fastness reveals no noticeable change in color both type of fabric due to rubbing.

Light fastness for cotton and jute fabric

For the purpose of this test, detergent washed cloths were dried in the sun and compared with those dried indoor. But no significant changes in color intensity were observed for both type of cloth. The coloration of the cotton fabric and the jute fabric after drying is displayed in Figure 9 and Figure 10.

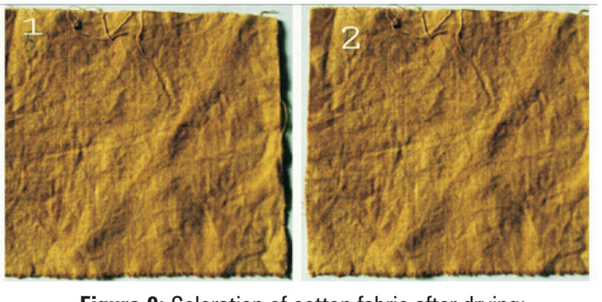

Figure 9: Coloration of cotton fabric after drying; (1) Indoor drying (2) Sun drying

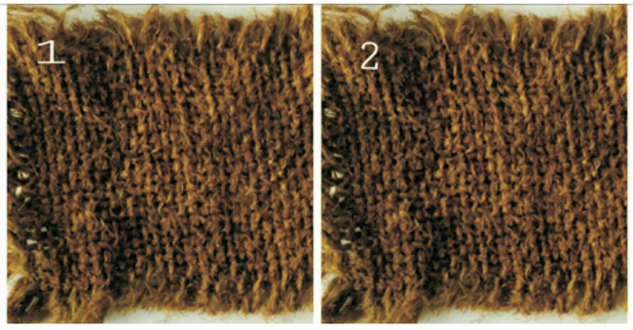

Figure 10: Coloration of jute fabric after drying; (1) Indoor drying (2) Sun drying

Conclusion

The present study showed that dye extracted from Calendula officinalis, can be successfully impregnated into the 100% cotton and jute fabrics. The whole process of extraction is easy, cheap and eco-friendly. The dye was extracted at a temperature of 60-80 °C in cheap, easily available, non-toxic universal solvent distilled water. The results show that the fabric dyeing potential of the Indian marigold flower is huge. This suggests that the naturally available dyes and pigments may be explored as a potential source in textile industry. Various color shades may be achieved by the manipulated use of safe and eco-friendly mordant like alum and the immersion time in the dye bath. Further investigation into this vicinity may improve the current scenario of dyeing and may be a boon in protecting our nature and environment.

Acknowledgement

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Conflicts of Interest

The authors do not have any conflict of interest.

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