

Cotton Dying with Natural Dye

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Abstract: Dyeing is a process of applying coloring matter directly on fiber, yarn or fabric without any additives. Natural dyes were used only for coloring of textiles from ancient times till the nineteenth century. As the name suggests, natural dyes are derived from natural resources. Coloring materials obtained from natural resources of plant, animal, mineral, and microbial origins were used for coloration of various textile materials. Today is the world of most scientific and advanced level of dyeing. There are huge numbers of process to do coloration. Natural and man-made colors are also used.

In this paper, the natural dyes are extracted and fabric dyeing is analyzed by applying dye on 100% pure cotton. At first stage we extract dye from *Butea Monosperma*. This dye was extracted with the help of boiling method. We find out Yellow color from *Butea monosperma*. The fabric dyed with extracted dye by using alum as a mordant. The dyed fabric tested for rubbing fastness, washing fastness, perspiration fastness, etc.

Keyword:- Natural dye, *Butea monosperma*, Alum, Rubbing Fastness, Washing Fastness, perspiration.

I. INTRODUCTION

Today dyeing is a complex, specialized science. Nearly all dyestuffs are now produced from synthetic compounds. This means that costs have been greatly reduced and certain application and wear characteristics have been greatly enhanced. But many practitioners of the craft of natural dyeing (i.e. using naturally occurring sources of dye) maintain that natural dyes have a far superior aesthetic quality which is much more pleasing to the eye. On the other hand, many commercial practitioners feel that natural dyes are non-viable on grounds of both quality and economics. Natural dyeing is now practiced only as a handcraft, synthetic dyes being used in all commercial applications. Some craft spinners, weavers, and knitters use natural dyes as a particular feature of their work.

Dyes are used for coloring the fabrics. Dyeing is a method which imparts beauty to the textile by applying various colors and their shades on to a fabric. Dyeing can be done at any stage of the manufacturing of textile- fiber, yarn, fabric or a finished textile product including garments and apparels. The property of color fastness depends upon two factors- selection of proper dye according to the textile material to be dyed and selection of the method for dyeing the fiber, yarn or fabric.

Human eyes sense the color due to dyes which absorb and reflect light at specific wavelengths. Majorly dyes are of two types - natural and synthetic dyes. The natural dyes are extracted from natural substances such as plants, animals, or minerals. Synthetic dyes are made in a laboratory.

Chemicals are synthesized for making synthetic dyes. Some of the synthetic dyes contain metals too.

Textiles dyed with natural dyes were found to yield poor color, have inadequate fastness properties. Metal ions of mordant act as electron acceptors for electron donors to form co-ordination bonds with the dye molecule, making them insoluble in water. Common mordants used are alum, chrome, stannous chloride, copper sulphate, ferrous sulphate etc.

The flower of *Butea monosperma* could be successfully used for dyeing of cotton to obtain wide range of soft and light colors by using combination of mordants. *Butea monosperma* (Binomial name), commonly known as Palash plant belongs to the family Fabaceae. This tree derives its name from the fact that the bright orange colour flowers. *Butea monosperma* trees grow superbly in the regions where the climate is hot, cold, and receive full sunlight.

In the present investigation flowers from *Butea monosperma* plant was used for extracting the dye and examined its possible usage in textile coloration. The effect of mordants employed in the dyeing with the *Butea monosperma* flower dye was also studied.

Sr.No.	Scientific Classification	
1.	Kingdom	Plantae
2.	Order	Fabales
3.	Family	Fabaceae
4.	Genus	<i>Butea</i>
5.	Species	<i>B. Monosperma</i>
6.	Binomial Name	<i>Butea Monosperma</i>

Table 1 :- Scientific Classification of *Butea Monosperma*

1.1 History of *Butea Monosperma* :-

Historically, Dhak forests covered much of the doab area between the Ganges and Yamuna, but these were cleared for agriculture in the early 19th century as the English East India Company increased tax demands on the peasants

It is used for timber, resin, fodder, medicine, and dye. The wood is dirty white and soft and, being durable under water, is used for well-curbs and water scoops. Good charcoal can be obtained from it. The leaves are usually very leathery and not eaten by cattle.

The gum is known as Bengal Kino and is considered valuable by druggists because of its astringent qualities and by leather workers because of its tannin.



Fig 1 :- Butea Monosperma

II. METHODOLOGY

2.1 Material:-

We have taken the 100% cotton fabric as substrate. The flower of Butea Monosperma collected for the extraction of dye.

2.2 Required Chemical:-

The basic chemicals used were:

- Sodium hypochlorite
- Sodium chlorite (NaCl)
- Hydrochloric acid (HCL)
- Sulphuric acid (H₂SO₄)
- Hydrogen Peroxide (H₂O₂)
- Sodium Carbonate (Na₂CO₃)
- Caustic soda or Sodium Hydroxide (NaOH)
- TRO

2.3 Mordants:-

Alum, Salt, Sodium Hypophosphate, etc. was used as mordant.

2.4 Process Parameter:-

- a) M:L (material to licker) ratio - 1:20
- b) Temperature - As per required
- c) Time - As per required

2.5 Testing:-

1. Washing Fastness: - 10 min, 20min, 30min.
2. Rubbin :- Dry & Wet Rubbing
3. Perspiration :- Alkaline

2.6 Extraction of Dye from Butea Monosperma:

- The flower of Butea Monosperma are collected and washed thoroughly with water to remove any impurities.
- They are dried at room temperature.
- Then boil it about 2 hours in a hot water bath for quick extraction of natural dye.
- At the end of 2 hours, the total color was extracted.
- The solution was double filtered and used to carry out our study. They are shown in the figures below.



Fig 2:- Extraction of Dye From Butea Monosperma

2.7 Pre-treatment on fabric (Scouring and bleaching on 100% cotton) :-

A. Scouring (Recipe):-

NaOH	- 3%
Soda ash (Na ₂ CO ₃)	- 2.5%
Detergent	- 1%
Temperature	- 90 ⁰ c
Time	- 3hrs
MLR ratio	- 1:20

Procedure for Scouring:-

1. Take known weight of sample.
2. Take the weight of chemical and water on the basis of sample weight in beaker.
3. Sodium Hydroxide, soda ash, detergent and water taken as per M:L ratio.
4. These solutions are treated for 15 min and stir it continuously at 45°C temperature.
5. Then dip the sample in the solution and raises the temperature of the solution up to 45 °C temperature.
6. Now the sample is treated for further 60 min. while slowly raising the temperature up to 70°C.
7. Now the fabric is treated at 90°C temperature for 3 Hrs.
8. After required time, the sample is taken out, wash and dry.

B. Bleaching (Recipe):-

• Hydrogen peroxide	-3%
• NaOH	-1.5%
• Soap	- 1
• Detergent	-1%
• Temperature	- 120 ⁰ c
• Time	- 90 min
• MLR ratio	- 1:20
• Sodium Carbonate	- 1%
• HCL	- 1 drop

Procedure for Bleaching:-

1. Take Known weight of sample.
2. Also take the weight of chemical and water on the basis of sample weight in beaker
3. Sodium Hydroxide, soda ash, detergent, NaOH was taken and water as per M:L ratio had been taken.
4. These solutions are treated for 15 min and stir it continuously at 45°C temperature.
5. Then dip the sample in the solution and raises the temperature of the solution up to 45 °C temperature.
6. Now the sample is treated for further 60 min. while slowly raising the temperature up to 70°C.

7. Now the fabric is treated at 90 °C temperature for 3. Hrs.
8. The sample is taken out & sample dip in the 1 drop of HCL acid solution.
9. Again sample wash and dry.

C. Preparation of Dye :- (Dyeing & Mordenting):-

Recipe:

• Dye	-10 ml.
• Nacl	-15 gpl
• Na ₂ CO ₃	- 5 gpl
• Mordant	- 5gpl
• TRO	-1 Drop
• Temperature	- 90 ⁰ c
• Time	- 2:30 min
• MLR ratio	- 1:20

Procedure for dyeing

1. Know weight of sample was taken and chemical, dye and water is taken in require quantity in beaker.
2. Dye paste was made by adding dye sodium chloride, sodium carbonate, and water as per M:L ratio.
3. Then this dye paste is added in required quantity of water and sample is dip into it.
4. This sample is treated for 15 min. in the solution and raises the temperature of the solution up to 40 °C in 20 min.
5. Now NaCl is added in the dye bath and treated for further 25 min. while slowly raising the temperature up to 70°C.
6. Now the fabric is treated at 70°C for 1 hrs then keeps the temperature up to 90° C.
7. After required time, the sample is taken out, wash and dry.

III. RESULTS AND DISCUSSION

3.1 Fastness Tests:-

Washing Fastness Test (Procedure):-

1. A 10 x 4 cm swatch of the dyed fabric is taken and is sandwiched between two adjacent fabrics and stitched.
2. The sample and the adjacent fabric were washed together.
3. Five different types of washing are specified as different washing methods.
4. The solution should be preheated to the required temperature of washing.
5. The liquor ratio should be 1: 50. After soaping treatment, the specimen is removed, rinse twice in cold water and then in cold running tap water.
6. Squeezed and dried in air at a temperature not exceeding 60°C the value is evaluated with the help of grey scales.

Result and Discussion

The result of the washing fastness test was taken on grey scale and it the following result was observed.

S.no	State of fabric	Light Shades
1	Dry Condition	4
2	Wet condition	2.5

Washing fastness scale reading-3-4

As the naturally obtain dyes does not have too much affinity with the fibre, but still by using mordant we have make this dye to stay on fabric for certain washes.

The colour started coming out after five washes where we can say that the mordant holding power of the dye on fabric can sustain upto five washes.

3.2 Rubbing Test (Procedure):-

A) Dry Rubbing:

1. Use the holding clamp to mount the specimen on the baseboard of the Crockmeter. The long direction of the specimen is parallel to the track of rubbing. Ensure the specimen lays Flat on the baseboard.
2. Two tests are performed, one along the direction of the warp/length and the other of the Weft/width.
3. Mount a dry rubbing cloth flat over the end of the peg on the Crockmeter and hold it tight by means of the spring clip provided. Ensure that the rubbing cloth is not placed on the diagonal in the direction that the peg is moving.
4. Rest the finger on the specimen, ensuring that the spring clip is not in contact with the test Specimen.
5. Rub the specimen back and forth over a straight track 100mm + 8mm long for 50 complete cycles (i.e. 10 times back and forth) at a rate of 1 second for each cycle.
6. It may be necessary to stretch some fabrics on to the base of the Crockmeter, to prevent the Fabric from rucking up.

B) Wet Rubbing:-

1. Wet out a rubbing cloth with distilled/de-ionised water to have about 100% pick up. A Suitable method is as follows, however any method where the rubbing cloth picks up its own Mass in water is acceptable.
2. It is important to understand the quality of water used here. As per standards, Grade water is a must.
3. Weigh the dry rubbing cloth and then thoroughly wet out in distilled/de-ionised water, squeeze the wet rubbing cloth between blotting paper and re-weigh on the balance. Make adjustments as necessary by either blotting off more water or re-wetting.
4. Use the following method to calculate 100% pick up of water-original weight of rubbing cloth x 2 (65% in AATCC method)
5. Carry out the appropriate test as the procedure for dry rubbing.
6. Allow the tested rubbing cloth to dry at room temperature.

Result and Discussion:-

In dry state it was found that the colour holding property was good for 10 complete cycle on face side and back side of the fabric. It was found very less colour change in the fabric as compared with grey scale. This might be due strong holding power of the dye molecules in dry state but as we go for wet condition the rating change to bigger difference, which signifies that as there is contact of water with the dye molecule it start splitting up or getting detached from the fabric easily. So the result of 2 suggests that wet rubbing fastness of the fabric is very poor.

Perspiration Test:-

1. The fastness of colored fabric with reference to alkali ne perspiration was tested..
2. For the alkaline (pH-8) liquors were prepared as 1:50 and the composite specimens were dipped in alkaline solution separately for 30 minutes.
3. Good and uniform penetration of the solution was ensured.
4. The liquor was poured off and the excess water and a ir bubbles, if anywere moved by passing the specimens in between two glass rods.
5. Composite specimens were then placed between glass/acrylic plates with a pressure of 12 kpaperspirometer.
6. The perspirometer was as kept for four hours at a temperature of 37 (±20C).
7. Afterwards, the fabrics were removed, separated and dried in air below 60°C.
8. The values were rated as per the grey scale.

Result and Discussion:-

The details of the values assigned for these properties are:

The rating was observed for perspiration test which was 3-4. This can be due the reason that dye molecule of butea monosperma does not have any profound effect on perspiration whether it may be alkaline or acidic. Thus we can conclude that butea monosperma is having good perspiration fastness.

S.no	Rating	Remark.
1	5	Negligible (Excellent)
2	4	Slightly changed (Good)
3	3	Noticeable changed (Fairly good)
4	2	Considerably changed (Fair)
5	1	Much changed (Poor)

V. ASSUMPTION AND LIMITATION

4.1 Assumptions:

The following assumptions were made for conducting experiment in this project:-

1. Since the treatment is carried out by beaker method.
2. The treatment was not so fast as compared to continuous process for dyeing but treatment time get 90 min for each sample during dyeing.
3. It was assumed that all instruments used for this study were accurate and precise.
4. It was assumed that equipment and operator errors were of a random nature and had no significant effect on the testing results.
5. It was assumed that all the reagent-grade chemicals used for this study were consistent in their properties from lot to lot.
6. It was assumed that we give the plain weave 100% cotton woven fabric, as received for used in this project were same.

4.2 Limitations:-

The following limitations were established conducting experiment in this project:-

1. Only 100% cotton, plain woven fabric was used in this project.
2. Here we used gray cotton for dyeing and after that it scoured and bleached for prepared for dyeing.
3. Only beaker dyeing was used for this project.
4. Only mordants are used, no any dye fixing agent were used.

VI. CONCLUSION

We used different type of natural dyes extracted from sources like flower of *Butea Monosperma*. This natural dyes was extracted with the help of boiling or grinding as per required for processing. In this work dye is applied on the 100% cotton fabric with different mordant (Alum, salt, sodium hypophosphate). We got results in various testing such as washing rubbing and perspiration.

Here, we got the better results of, perspiration and rubbing (dry) fastness test. Also the results of *Butea monosperma* (Grinding) was not per the satisfaction on 100% cotton.

This flower of *butea monosperma* is easily available and after drying it is useful in many ways. This natural dye

does not have any effect on human body. The results obtained from the form of dyeing which was extracted from flower of *Butea Monosperma*, are quite satisfactory.

Our analysis was to choose proper dyeing recipe for cotton so that we could get the optimum results. From our research we came to know that the natural dyes along with mordant are giving better result on 100% cotton fabric for given natural dyes.

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