Design and Development of Waterfall Frock Finished with Natural Plant Dye

Vinotha.T[1], T.R.Indumathi M.Sc., M.Phil., (Ph.D.)[2]
B.Sc., Student, Department of Costume Design and Fashion, Dr.N.G.P Arts and Science College, Coimbatore
Assistant Professor, Department of Costume Design and Fashion, Dr.N.G.P Arts and Science College, Coimbatore

Abstract-The main idea of extracting dyes from plant (natural) sources is to avoid the environmental pollution. Present days with global concern over the use of eco-friendly and biodegradable materials, considerable research work is being undertaken around the world on the application of natural dyes in textile industry. The effluent problems of synthetic dyes occur not only during their application in the textile industry, but also during their manufacture and possibly during the synthesis of their intermediates and other raw materials. The use of natural dyes for textile dyeing purposes, decreased to a large extent after the discovery of synthetic dyes in1856. Dyes derived from natural sources have emerged as an important alternative to synthetic dyes. Our health is negatively impacted by synthetic dyes and all of the processes involved in regular dyeing. Natural colours can lessen the danger of synthetic dyes. As indigo is a natural dye, it has been utilised for thousands of years to colour fabrics. The objective of this study is to explore various raw materials used for the extraction of natural dyes includes *Solanum torvum, Terminilia chebula, Coffea,* the technique used to extract various natural dyes (aqueous method), and the characteristics of cloth (Poplin) that has been coloured using those dyestuffs. In studies, the majority of natural dyes demonstrated extremely good fastness characteristics. The dyes may be collected from a variety of sources, including trees, bark, leaves, flowers, and more. The majority of natural dyes have unique qualities including anti-microbial, low toxicity, low allergenicity, and UV protection.

Keywords: *Terminilia chebula, Solanum torvum, Coffea,* Poplin, natural dyes, colour fastness, eco-friendly.

1. INTRODUCTION

One of the most environmentally destructive processes is the processing of textiles. Almost 250 gallons of water are required to make just one T-shirt from start to finish. The waste from dyeing contains thousands of chemicals and pollutants that have been dumped nearby in rivers and canals. That's why we should step forward for eco-friendly processing and use eco-friendly chemicals as well. A new era of less polluting textile processing may be on the horizon with the use of natural dyes in the colouring process. Green and eco-friendly textiles are the newest fashion and textile trends. The goal of all fashion companies is to make the world more liveable and less polluted. Beginning on January 1st of the twenty-first century, the globe is moving towards safer, less recyclable, hazardous technology. Thus, the use of natural dyes that are safe for the environment, biodegradable, nontoxic, and less polluting is growing daily in a variety of industries. The majority of natural dyes are protected from damaging UV rays of sunlight by their UV absorption properties.

The largest markets for natural dyes are in foods, medications, cosmetics, and textiles. Natural and synthetic textile fabrics used to be dyed for added value, aesthetics, and consumer demand. Prior to the discovery and widespread use of synthetic colours and dyes, ancient peoples first coloured textiles using hues from natural sources. The majority of textile dyers and manufacturers have switched to using synthetic colourant due to the easy availability of pure synthetic dyes of various sorts and classes and its economic benefits. The environmental friendliness of almost all synthetic colourants is threatened by the risky chemical methods used to create them from petrochemical sources.

Many uses are available from the traditionally extracted natural dyes. Natural dyes are derived without the use of chemicals from a variety of substances found in nature, such as plants (such as

indigo and saffron), insects (such as cochineal beetles and lac scale insects), animals (such as some species of molluscs or shellfish), and minerals (such as ferrous sulphate, ochre, and clay). Many chemicals are used in the textile industry to colour textiles. Yet, throughout the last decades of the twentieth century, public interest in natural dyes was once again sparked by environmental concerns about the manufacturing and use of synthetic dyes. Nevertheless, due to specific technical and ecological challenges associated in the manufacturing and use of these dyes, such as their unavailability in ready-to-use form, the overall proportion of natural dyes in the textile industry is only around 1%. Moreover, overusing natural resources to make colours might imperil endangered species and cause deforestation.

Natural colours, as opposed to synthetic dyes, generate extremely rare, calming, and gentle colours. Conversely, synthetic dyes, which are readily accessible at a low cost and generate a broad range of hues, occasionally cause skin allergies and other harm to the human body, produce toxicity/chemical hazards during their manufacture, emit unfavourable/ hazardous/toxic compounds, etc. It is necessary to adopt the suitable and standardised dyeing procedures for that specific fiber-natural dye system in order to successfully employ natural dyes for any specific fibres in the commercial sector. The production of confectionery, other food items, textiles, cosmetics, medications, leather, paper, paint, ink, and other things all employ natural dyes extensively. Turkey berry (Solanum torvum), coffee dust (Coffea), and myrobalan are a few of the natural ingredients utilised here to extract colour (terminalia chebula).

2. MATERIALS AND METHODS

2.1.Selection of fabric

Poplin fabric[100% cotton]

Plate 1: Poplin fabric

Poplin is a cotton fabric that has a simple weave and extremely little horizontal "ribs" running through it. This fabric has a smooth, shiny surface and is robust and crisp. It is frequently utilised in shirts for both sexes, dresses for ladies, and other products like sportswear and raincoats. Poplin may be found in a number of apparel items that you can wear all year round because it is such an everyday, essential fabric. Poplin is used to create both women's and men's shirts, as well as women's dresses and skirts and men's trousers and jackets. It is a flexible material with a light shine that enhances the attractiveness and drape of any article of apparel.

3.2. Selection of natural components

3.2.1 Turkey berry (s*olanum torvum*)

Plate 2: *Solanum torvum*

The plant typically grows to a height of 2 or 3 m with a basal diameter of 2 cm, although it may grow as high as 5 m and a basal diameter of 8 cm. At ground level, the shrub typically has a single stem, but it may branch on the lower stem. The lenticels on the stem bark are high and practically smooth in colour. Over an ivory hue, the inner bark bears a coating of green (Little and others 1974). The author's plants had strong laterals and weak taproots since they were on hard soil. White roots are present. Just the twigs that are still growing have foliage. The twigs are star-shaped and gray-green in colour. The spines on the plant, including the midrib of the leaf, are short, slightly curved, and vary in thickness.

3.2.2 Myrobalan [*terminalia chebula*]

Plate 3:*Terminalia chebula*

The Terminalia chebula tree's ground nuts are used to make this dye. This tree may be found in south China, Indochina, Burma, Thailand, India, Sri Lanka, and Nepal. When used, it may be categorised as both a mordant and a dye, producing a light buttery yellow. Due to the soft, warm colour it gives cotton, it is a crucial tannin-based mordant in Southeast Asia and India. Myrobalan serves as a strong base for overdyeing. Moreover, it is the ideal shade to use as a base for teal beneath a single indigo dip. Myrobalan needs between 15-20% WOF when used as a tannin mordant. Use 20–30% WOF to produce a soft butter yellow.

3.2.3Coffea dust

Plate 4:*Coffea* dust

Coffee, a coffee drink created from brewing roasted, ground, and water with coffee beans belonging to one of two types of tropical evergreen plants of the genus Coffea in the madder family. In this regard, the ability of used coffee grounds to colour and functionalize textiles was investigated. Using a manual espresso machine, waste coffee grounds that were gathered from a nearby coffee shop were extracted to create the colouring solution. Using a lab infrared dyeing equipment, the used coffee extract was applied to wool garments. The materials were then mordanted with a tannic acid aqueous solution once the dyeing procedure was finished.

Fabric finished with plant seed dye

3.3. Desizing and mordanting the fabric with alum

Plate 5: Desizing

Plate 6 Alum Plate 7 Mordanting the fabric with alum

3.5.Dyeing of fabric and printing

Dyeing

1. Prepare your dye by cutting up your fruit and seeds while the water is heating. Plan your projects based on the 2:1 ratio of water to dye ingredient.
2. Simmer the colouring ingredients and water. You'll often start to notice colour extractions after around 30 minutes of simmering. Turn off the heat, then simmer once more until the desired hue is achieved. Just as with other natural dyeing techniques, the timing of adding the cloth is entirely up to you.
3. Add your fabric.Allow nature to take its course while checking on your cloth occasionally.
4. Remove your fabric from the dye bath. Rinse the garment with cold water after exiting the bath.

Plate 8*: Solanum torvum*

Plate 9*: Terminaila chebula*

Plate 10*: Coffea dust*

Vegetable printing

Plate 11 : Leaves for Printing fabric

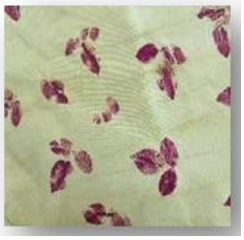

Plate 12: Leaf Printed

Onion printing

Plate 13:Onion for Printing printed fabric

Plate 14: Onion block

The printing paste in this case is manufactured from natural ingredients. Beetroot juice is extracted, thickened, and simmered to create printing paste. The patterns are printed on the cloth using the vegetable block printing technique. The motifs on the cloth are imprinted using onion and rose leaves.

3.6.Testing and evaluation:

1.Colour fastness due to washing:

- Purpose: This testing is done to find out how water resistant a fabric's colour is.
- Sample size: 40 cm whole width of cloth; sample collection: random sampling
- Atmosphere: between 70 and 90 degrees Fahrenheit
- Conditioning time: at least an hour • Apparatus: per spirometer, air oven, aluminium container, grey scale for evaluation (grade from 1 to 10).

Table 1: Grey Scale particulars for Colour fastness of natural dyed fabric

S. No.	Grade	Degree of colour fastness
1.	Grade 1	Very poor
2.	Grade 2	Poor
3.	Grade 3	Fair
4.	Grade 4	Slightly fair
5.	Grade 5	Moderate
6.	Grade 6	Good
7.	Grade 7	Very good
8.	Grade 8	Excellent
9.	Grade 9	Outstanding

Testing procedure

2.Colour fastness due to sunlight:

- Trim the specimen to 40 mm by 100 mm in size.
- Cut the sample size of the common covering cloth.
- Place the specimen between the common covering cloth, then sew along all four edges.
- Soak the sandwiched specimen completely for 30 minutes with distilled water at a 1:50 ratio.
  The moist sample should now be sandwiched between two plastic plates, which should all be stacked one on top of the other.
- Now place the plates on the per spirometer's bottom metal plate.
- Set the top metal plate in place and use thumb screws to adjust the load.
- After that, maintain the loaded instrument in the air oven at 38+/-1° C for 4 hours.
- After four hours, remove the test specimen from the apparatus.
- Check for colour changes by comparing the test specimen to the original sample; scale comparisons are also recommended.
- Compare the brand-new sample to the industry standard tableclot

Sunlight fastness

The ability of coloured materials to resist fading in the presence of sunlight is known as light fastness. The behaviour of the sample in real-world use circumstances may be estimated by exposure to sunlight, but it takes a lot of time.

In standard condition-

1. Half of the sample and standards are mounted with them exposed to light. A glass sheet must be at least 5 cm away from the sample to protect it from the elements (well ventilation due to moisture and heat). The specimen and standards should be maintained in the sun for 24 hours straight to achieve the desired fading.
2. 8 The tested sample and the reference sample are both cut to the same size and fitted onto the template.
3. At an angle equivalent to the location's latitude, the specimens are displayed in a frame facing south in the northern hemisphere and north in the southern hemisphere.
4. The test is run by mounting the standards and samples as shown in fig.

5. A glass sheet must be used to shield the sample from rain.
6. A layer of opaque cloth covers one-fourth of the sample and standards. As a result, it is exposed until standard-1 fades and becomes comparable to standard-4 when the colour grey scale changes.
7. Cover the area of the sample and standards that was previously exposed to the air with another opaque sheet. As a result, when the colour grey scale changes, it is exposed until standard-7 fades and becomes equivalent to standard-4. Three stripes will be seen in the specimen and the standards, and the result will be stopped and the opaque removed.
8. The zones of the specimen and the zones of the standards are compared. The percentage of the wool standard that has faded to the same degree as the sample's exposed area is the indicator of a dyed sample's light fastness.

4. RESULTS AND DISCUSSION

4.1. Colour fastness to washing

The colour fastness to washing for the specimen under hard water are shown below

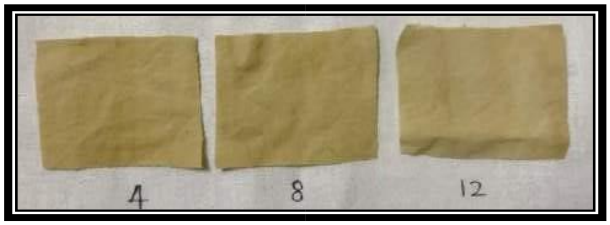

Plate 15: (*Coffee* dust dyed fabric after washing)

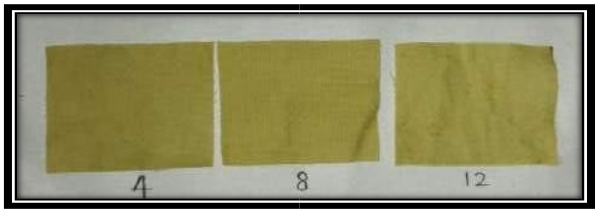

Plate 16:(*Solanum torvum* dyed fabric after washing)

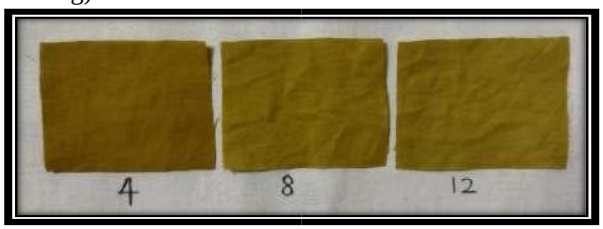

Plate 17:(*Terminalia chebula* dyed fabric after washing)

Table 2: Analysis of wash fastness for natural dyed fabrics

Name of the Component	Grade	Degree of Fading
Solanum Torvum	Grade 6	Slight Fading
Coffea	Grade 8	Moderate Fading
Terminalia Chebula	Grade 9	No Fading

From the above table standardization tests for colour fastness to washing, water, and other particular circumstances were discussed . After 12 washes, tests revealed that the colour fastness of *terminalia chebula* is outstanding, *solanum torvum* is good and that *coffea's* is excellent. Depending on how the textile items are designed and how they are going to be used, colour fastness testing could be more crucial.

4.2 Colour fastness to sunlight:

The colour fastness to sunlight for the specimen are shown below

Plate 18 *Solanum torvum* dyedfabric)

Plate 2 Coffea dust dyed

Plate 21:(*Terminalia chebula* dyed fabric)

Table 3: Analysis of sunlight fastness in natural dyed fabrics

Name of the Component	Grade	Degree of Fading
Solanum Torvum	Grade 6	Slight Fading
Coffea	Grade 6	Slight Fading
Terminalia Chebula	Grade 9	Out Standing

The capacity of the cloth to survive the sun's rays is referred to as colour fastness to sunlight. The resistance qualities of the dyes listed below are assessed, with the following findings. *Solanum torvum*: Pertained Good result
Coffea: Pertained Good result
Terminalia chebula: Pertained Outstanding result

5. SUMMARY AND CONCLUSION

With a few exceptions, most natural dyes and colours are eco-friendly. Several of the natural hues are not only eco-friendly but also have additional benefits for their skin-healing properties. Regarding the fastness qualities of natural dyes, there is a misconception that the dyes lack the necessary fastness qualities. It is one of the reasons businesses avoid using natural colours, and customers also avoid using them. We can see in the results part of this project that the dyes used to colour the fabric received an excellent fastness rating. It has been observed that applying a mordant also has an impact on the colour fastness and strength. The effects of using a natural or synthetic mordant on coloured materials vary. So, in order to employ natural dyes industrially, both companies and consumers must take the initiative to replace synthetic colours with more and more natural ones.

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