# PROMOTING SUSTAINABILITY IN FABRIC DYEING USING FLOWER-DERIVED NATURAL DYES

**Ms. Sherin Treasa*[1], Dr. Vinitha Paulose*[2]**
[1], *Department of Fashion Designing, St. Teresa's College (Autonomous)*
*Ernakulam, Kerala, India*
[2] *Department of Fashion Designing, St. Teresa's College (Autonomous)*
*Ernakulam, Kerala, India*

## ABSTRACT

*This study explores the potential of utilizing African Marigold (Tagetes Erecta) as a sustainable natural dye for the development of eco-friendly home linens. With growing concerns over environmental degradation and the detrimental impacts of synthetic dyes on ecosystems, there is a pressing need to identify eco-conscious alternatives. The unique properties of African Marigold, rich in natural pigments like carotenoids and flavonoids, make it an attractive candidate for fabric dyeing. The results indicate that African Marigold offers a promising solution for sustainable fabric dyeing, as it not only imparts a wide spectrum of captivating hues to textiles but also promotes environmentally responsible practices in the textile industry. This research contributes to the growing body of knowledge concerning eco-friendly dyeing processes and reinforces the importance of embracing natural resources to build a more sustainable future for the textile sector.*

**Keyword:** *Sustainable, Dyeing.*

## 1. INTRODUCTION

Eco-friendly fabrics are a burgeoning trend in the textile industry, driven by increasing environmental consciousness and a desire for sustainable living. Embracing eco-friendly fabrics not only promotes a healthier living environment but also supports ethical practices in the supply chain, ensuring fair labor conditions and reducing carbon emissions [1]. These fabrics are crafted from natural fibers, organic materials, or recycled sources, minimizing the ecological impact during production and use. Popular options include organic cotton, hemp, bamboo, and Tencel, which are grown without harmful chemicals and pesticides, require less water and energy to produce, and are biodegradable [2]. With a focus on comfort, durability, and style, these environmentally conscious textiles offer an ideal solution for those seeking to create a harmonious, eco-friendly home while contributing to a more sustainable and greener future.

Dyeing is an integral part of which textile coloration is done to make the fabric lively. Dyeing is an ancient art which predates written records, and it was practiced since bronze age. Consumers are becoming increasingly conscious to environmentally friendly consumer goods and are much concerned about green processing. The tendency of eco-friendliness in textiles is important as it encounters the skin for a prolonged period. Natural flower dyes have been used for centuries as a sustainable and eco-friendly alternative to synthetic dyes for dyeing fabrics [3]. These dyes are derived from various flowers, each imparting unique and vibrant hues to textiles.

One of the commonly used natural flower dyes is derived from the African Marigold (Tagetes Erecta), known for its bright yellow and orange shades. The use of natural flower dyes not only ensures that fabrics are free from harmful chemicals, making them hypoallergenic and skin-friendly, but also reduces the environmental impact of dyeing processes [4]. While natural flower dyes are generally more sensitive to light and washing compared to

some synthetic dyes, advancements in dyeing techniques and mordanting have improved their color fastness. Additionally, the inherent variations in natural dyes lend a unique charm and artisanal appeal to the dyed fabrics. As the world embraces sustainability and eco-conscious practices, the revival of natural flower dyes in the textile industry continues to grow. Their use not only supports local communities involved in traditional dyeing practices but also promotes biodiversity and reduces water pollution. Incorporating natural flower dyes into fabric dyeing is a beautiful way to celebrate the splendor of nature while ensuring a greener and more environmentally friendly approach to textiles.

Cotton and linen are two of the most sustainable fabrics in the textile industry, known for their eco-friendly attributes and widespread popularity among consumers seeking environmentally conscious choices [5]. Linen, derived from the flax plant, is another sustainable option. Flax is a resilient plant that requires less water and fewer pesticides compared to other crops. It grows quickly and thrives in various climates, making it a more sustainable choice for farmers. Linen fibers are strong and durable, leading to longer-lasting textiles and reducing the need for frequent replacements. Like cotton, linen is biodegradable, ensuring a reduced ecological footprint.

Both cotton and linen have excellent breathability and moisture-wicking properties, making them ideal for clothing and home textiles, especially in warm climates. Their natural fibers create comfortable and soft fabrics that are kind to the skin and suitable for various applications, from clothing and beddings to curtains and tablecloths. Furthermore, the versatility of cotton and linen allows for easy blending with other natural or sustainable fibers, enhancing their properties and creating more eco-friendly textile options. Cotton can be combined with Tencel (made from sustainably sourced wood pulp) to create a fabric that is even more environmentally friendly and boasts a luxurious feel [6],[7].

African Marigold is a captivating flower that not only adds beauty to gardens but also holds great potential as a natural dye for textiles [8]. The marigold's petals contain potent natural pigments, mainly carotenoids (240.25 mg/100g for dry flowers and 25.71mg /100g for fresh flowers) and flavonoids, which are responsible for its bright yellow and orange hues. When compared to unpreserved flowers, well-preserved marigold flowers had a higher output of xanthophyll content (105.19 g/Kg). In addition to preventing oxidant-induced cell damage, cancer, cardiovascular disease, and, most critically, age-related macular degeneration (AMD), xanthophylls also reduce the auto-oxidation of cellular lipids. A good source of lutein is the marigold flower. Because it dissipates free radicals produced by the action of UV radiation on the retina of the eye, it is particularly useful as an antioxidant in the protection of the eyes [9] When used as a natural dye, African Marigold can impart these striking colors to fabrics, creating a range of warm and earthy tones. Extracts of Tagetes Erecta is known to possess antibacterial, antimicrobial, hepatoprotective, analgesic and anti-oxidant activity [10].

One of the significant advantages of using African Marigold for natural dyeing is its eco-friendliness. Unlike synthetic dyes, which often contain harmful chemicals and heavy metals, African Marigold is non-toxic and biodegradable, making it safe for both the environment and the individuals involved in the dyeing process. Additionally, cultivating African Marigold for dyeing purposes can promote biodiversity and support sustainable agriculture practices.

The use of African Marigold as a natural dye also encourages artisanal traditions and fosters cultural heritage. In various parts of the world, especially in regions where the plant is native, communities have been using marigold dyes for generations, passing down valuable knowledge and techniques through the ages. African Marigold represents a sustainable and visually appealing option for natural dyeing. Its warm and cheerful tones not only add a touch of nature to fabrics but also align with the growing demand for eco-friendly and responsible practices in the textile industry.

## 2. MATERIAL AND METHODS

### 2.1 Fabric Selection

Hundred percent pure Cotton (C) and Linen (L) fabric of plain weave structure were selected for dyeing. Cotton and Linen fabric were washed repeatedly to remove the dirt and impurities. The fabrics were then dried in shade and kept ready for dyeing.

### 2.2 Selection of Marigold Varieties

Two varieties of Tagetes Erecta, African Marigold Orange and French Marigold Yellow (Fig. 1) were collected from the temple premises, sorted, and cleaned. Impurities were removed thoroughly. The petals of each flower were plucked and kept separately in sealed covers.

**Fig -1**: Tagetes Erecta- African Marigold Orange and French Marigold Yellow

### 2.3 Extraction of Dye from the Flower

The collected orange and yellow flower petals were carefully dried under the shade separately for 4-5 days. The dried petals were then finely grinded and powdered. The fine powder of marigold flower was mixed with required amount of water and boiled for 30 minutes at room temperature in separate containers. The extracted dye solution was filtered twice to get a clear solution. The solution was kept aside for further process.

### 2.4 Selection of Mordant

A mordant is necessary to fix the dye to the fabric. Mordants are also mineral salts, used to increase the affinity of the material. Potassium Alum was used as a mordant to fix the dye to the material.

### 2.5 Desizing

Desizing is the process of removing the sizing material from woven fabric. A stainless-steel bath vessel was taken with 10 litres of water and non-ionic detergent was added. The cotton and Linen fabric was rinsed well in cold water and was then immersed into the water bath for 1 hour at 80°C to remove starch or any other impurities present in the fabric. The fabrics were then taken out, rinsed several times and then dried in shade.

### 2.6 Dyeing

For dyeing, simultaneous mordanting and dyeing method was adopted. The cotton fabric (C) was directly immersed into a vessel in which orange flower extract solution (O) which was taken in the M:L ratio of 1:20. The required amount of mordant was added into the dye solution Another vessel with yellow flower extract solution (Y) was taken in the M:l ratio of 1:20 and cotton fabric was dipped into it along with the required mordant. Both the vessels containing the dye liquor and fabric was gently boiled at $75^0$C for one hour. Similarly, Linen fabric (L) was also taken and immersed into two different vessels having orange flower extract solution(O) and yellow flower extract solution(Y) in the M:L ratio of 1:20 with the required mordant and gently boiled for one hour by maintaining the temperature at $75^0$C. The fabrics after boiling were kept overnight in the dye solution for cooling and absorption of the dye into the fabric. The dyed materials were then taken out and dried in shade. The nomenclature of the dyed fabrics is given in Table I

**Table -1: Nomenclature of the dyed Fabrics**

| Fabric Dyed | Nomenclature |
|---|---|
| Cotton fabric dyed in orange flower extract | CO |
| Cotton fabric dyed in yellow flower extract | CY |
| Linen fabric dyed in orange flower extract | LO |
| Linen fabric dyed in yellow flower extract | LY |

## 3. RESULTS AND DISCUSSION

### 3.1 Visual Evaluation

The fabrics dyed with two different flower extracts CO, CY. LO and LY were visually evaluated for general appearance, color, evenness in dyeing, texture and lusture. The results of evaluation is given in Table 2 and Fig.2.

**Table – 2: Visual Inspection**

| Sample | General Appearance | Color | Evenness in Dyeing | Texture | Lusture |
|---|---|---|---|---|---|
| CO | 70% | 73% | 60% | 80% | 50% |
| CY | 80% | 77% | 75% | 85% | 64% |
| LO | 93% | 95% | 80% | 94% | 90% |
| LY | 100% | 98% | 98% | 99% | 99% |

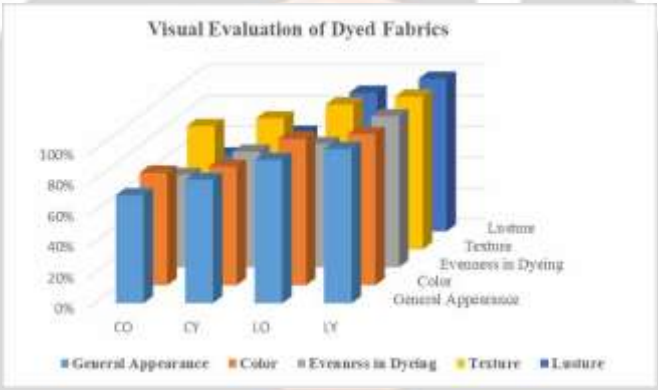


**Chart -1:** Visual Evaluation of Dyed Fabrics

From the results of visual evaluation Sample CO was rated as excellent by 70% in general appearance 73% good in brilliancy of colour, 60% evenness in dyeing, 80% soft texture and 50% high in lustre. Sample CY was rated as excellent by 80% in general appearance, 77% good in brilliancy of colour, 75% evenness in dyeing, 85% soft in texture and 64% high in lustre.

Sample LO was rated as excellent by 93% in general appearance, 95% good in brilliancy of colour, 80% evenness in dyeing, 94% soft texture and 90% high in lustre. Sample LY was rated as excellent by 100% in general appearance, 98% good in brilliancy of colour, 98% evenness in dyeing, 99% soft texture and 99% high in lustre.

### 3.2 Evaluation of samples by Test methods

#### 3.2.1 Analysis of Tensile Strength

The tensile strength of original and dyed samples in the warp and weft direction was taken. The results of average tensile strength of warp and weft yarns are given in Table 3

**Table -3: Analysis of Warp and Weft Tensile Strength**

| Sample | Warp Average (%) | Weft Average (%) |
|---|---|---|
| C | 87.2 | 70.4 |
| CY | 94.8 | 79.0 |
| CO | 91.8 | 87.2 |
| L | 56.6 | 31.4 |
| LY | 28.8 | 60.2 |
| LO | 61.2 | 29.8 |

From the above table it was noted that linen and linen dyed fabrics (LO, LY) have more tensile strength when compared to cotton dyed fabrics.

### 3.2.2 Crease recovery

The crease recovery of the samples was taken in the warp and weft direction. The test results are shown in the below tables:

**Table -4: Analysis of Crease Recovery**

| Sample | Warp Average ($Kg/Cm^2$) | Weft Average ($Kg/Cm^2$) |
|---|---|---|
| C | 30.53 | 32.77 |
| CY | 31.69 | 31.23 |
| CO | 28.73 | 29.48 |
| L | 43.41 | 46.05 |
| LY | 40.84 | 55.45 |
| LO | 36.09 | 55.05 |

Table 3 reveals that cotton and cotton dyed fabrics (CO, CY) were having greater crease recovery than linen fabrics

### 3.2.3 Analysis of Abrasion test

Abrasion test for all the fabric samples were done in Rotary Abrasion Tester and the results are given in Table 5. The results from Table 5 reveals that all the dyed fabrics have good abrasion resistance

**Table- 5: Analysis of Abrasion test of fabric samples**

| Samples | Degree of Shading |
|---|---|
| C | 3.5 |
| CY | 4.25 |
| CO | 4.25 |
| L | 4.25 |
| LY | 4.25 |
| LO | 4 |

### 3.3 Determination of Color Fastness Tests

Analysis of color fastness to rubbing, washing, sunlight and pressing was done for all the dyed fabrics. The results of the color fastness tests are given in Table 6 and Fig.3.

**Table- 6: Determination of Color Fastness**

| Determination of Color Fastness | | | | | |
|---|---|---|---|---|---|
| **samples** | **Rubbing** | | **Washing** | **Sunlight** | **Pressing** |
| | Dry | Wet | | | |
| CO | 4.6 | 3 | 4 | 3 | 3 |
| CY | 4.3 | 2.3 | 3 | 4 | 4 |
| LO | 4 | 3.3 | 4 | 3 | 4 |
| LY | 4 | 3.3 | 3 | 4 | 5 |

From Table 6, it was observed that the fabric samples showed only slight staining while dry rubbing and considerable staining in the wet rubbing for both cotton and linen fabrics. Sample LY was rated as good as it showed slightly stained and color change. LO was rated as fair as it was noticeably stained and visible color change in color fastness to washing test. The sample CO and CY was rated as fair as it was noticeably stained and visible color change was seen during the test.

Sample LY was rated as good as it showed slightly stained and color change. LO was rated as fair as it was noticeably stained and visible color change in color fastness to sunlight. The sample CO was rated as fair as it was noticeably stained and visible color change was seen during the test. And CY was rated as fair as it was noticeably stained and visible color change in color fastness to sunlight.

Sample LY was rated as excellent as it showed no stain or change in color and LO was rated as good as it showed slightly stained and color change in color fastness to sunlight test. The sample CO was rated as fair, as it was noticeably stained and visible color change was shown during the test and CY was rated as good as it showed slightly stained and change in color.

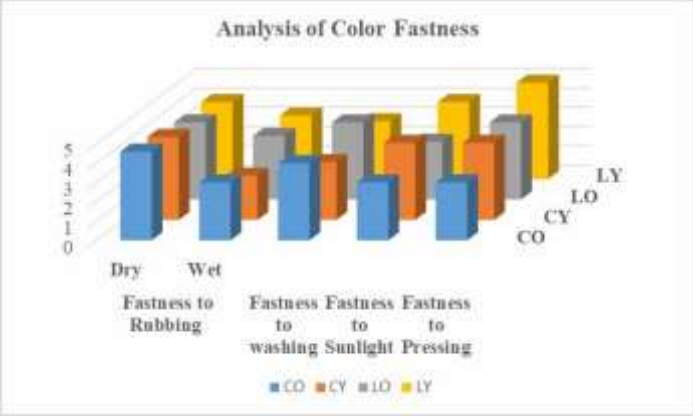


**Fig- 2:** Analysis of Color Fastness

## 4. CONCLUSION

As green consumerism and environmental friendliness are on an increase, the use of natural dyes is the latest trend. Researchers are exploring natural substances and testing them for their potential as dyes. Eco and Organic fabrics once considered an alternative to manmade synthetic fibres and are now entering into the mainstream. Consumers are becoming increasingly very much conscious to environmentally friendly consumer goods and much concerned about green processing. Natural dyes exhibit several important properties that provide them a significant edge over synthetic dyes. Fabrics dyed with natural dyes are also free from carcinogenic compounds. Natural dyes can be obtained from plants, animals, and mineral bases.

The present study deals with the natural dyeing of eco-friendly fabrics using temple waste flower Tagetes Erecta of two variants that gives two different colors orange and yellow. Unbleached cotton and linen fabrics were selected for the study. Dyeing was carried out using simultaneous mordanting with alum as mordant. It was noted from the results that both cotton and linen fabrics showed good affinity to both the dyes. Form the visual inspection and tests performed the fabrics CO, CY, LO, and LY fair to average to excellent results. The dyed samples were also studied for their yarn count, tensile strength, crease recovery, abrasion resistance and color fastness tests, of which the results were found to be satisfactory. The study revealed that the temple waste flower Tagetes Erecta could be used as a natural dye for dyeing eco-friendly fabrics.

## 5. REFERENCES

[1] Muthu. S. S. 2015. Handbook of Sustainable Apparel Production. CRC Press. 120- 135.
[2] Sirohi N. 2016. Eco friendly Fibres. International Journal of Home Science. 2(3): 24-36
[3] Padma. S. 2016. Handbook of Natural dyes for Industrial Applications.P-36.
[4] Gopi. G. Elumali A. Jayasri P. 2012. A Concise Review on Tagetes Erecta. International Journal of Phytopharmacy Research. 3(1):16-19.
[5] Ashok. K.R. 2013.Economic and Environmental Impact of Cotton. Research in Agricultural and Applied Economics.22(4). 26-32.
[6] Tzanko, T. Margarita, C. and Cavaco, P. 2001. Bio-preparation of Cotton Fabric. Handbook of Fiber Science and Technology.P-234
[7] Sonia M.S. Kaushik. M.D.2011. Comparative Analysis between Conventional Pre-treatment and Bio preparation. International Journal of Engineering and Technology 11(03): 3-4
[8] Arora. J. Agarwal.P. Gupta. G. 2017. Rainbow of Natural Dyes on Textile Using Plants Extract. Sustainable and Eco-Friendly Process.P-565
[9] Beniwal.B.S., Renu Gulia S.S., Singh Dalal. R.P.,(2017)., Biochemical Constituents Studies in African Marigold Germplasm,Chemical Science Review and Letters,6(21),618-623.
[10] Priyanka,D., Shalini, T., Navneet.V.K, (2013). A Brief Study on Marigold (Tagetes Species): A Review. International Research Journal of Pharmacy.,4(1),43.45