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PERFORMANCE EVALUATION OF ECO-FRIENDLY PIGMENTS IN DURABLE FABRIC PAINTING

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ABSTRACT

Eco-friendly pigments are gaining importance in textile applications because they reduce environmental pollution and are safe for human health. The present study focuses on the performance evaluation of eco-friendly pigments used in durable fabric painting. Natural and environmentally safe pigments were prepared and applied on selected fabric samples using suitable painting techniques. The painted fabrics were then subjected to different tests to evaluate their quality and durability. Fabric thickness was measured to understand the structural properties of the material before and after painting. Fabric weight was also analyzed to determine the effect of pigment application on the fabric. A pH test was conducted to identify the acidity or alkalinity level of the treated fabric and to ensure skin safety. In addition, colour fastness to crocking tests (both dry and wet) were carried out to evaluate the resistance of colour transfer during rubbing. The results of these tests helped to determine the stability and performance of eco-friendly pigments on fabric surfaces. The findings indicate that eco-friendly pigments provide satisfactory colour appearance and acceptable durability. These pigments also support sustainable textile practices by reducing the use of harmful synthetic chemicals. The study highlights the potential of eco-friendly pigments as a suitable alternative for durable fabric painting. Thus, eco-friendly pigment application can contribute to environmentally responsible textile production.

Keywords: *Eco-friendly pigments, Fabric painting, Sustainable textiles, Colour fastness, Fabric thickness, pH test, Durable textile finishing.*

I. INTRODUCTION

Natural pigments are gaining importance in textile applications because they are biodegradable and environmentally safe. They explained that plant-based pigments can be effectively applied on cellulosic fabrics and provide acceptable colour strength. These pigments also reduce the harmful effects caused by synthetic dyes in textile processing. [Shahid and Mohammad (2013)]

Explained that eco-friendly colourants obtained from natural resources are widely used for textile colouring. They reported that natural pigments show good compatibility with cotton fabrics and support sustainable textile production. Their study highlights the importance of natural pigments in environmentally responsible textile finishing. [Samanta and Agarwal (2009)]

The extraction and application of natural pigments from plant materials for textile colouring. The authors found that proper preparation and application methods improve colour stability on fabrics. Their research also emphasized the environmental advantages of using natural pigments. [Bechtold et al. (2003)]

Eco-friendly pigments derived from plants are suitable for fabric decoration and painting. The study showed that these pigments produce attractive shades and reduce environmental pollution. The authors also highlighted their potential in sustainable textile design. [Ali et al. (2018)]

Natural colourants have been traditionally used in textile decoration for centuries. The author stated that these pigments are safer for both the environment and human health compared to synthetic dyes. Their application in textile painting also supports eco-friendly production methods. [Gulrajani (2011)]

Stated that natural pigments extracted from flowers, leaves, and roots can be used effectively in textile colouring. The study highlighted that these pigments provide unique shades and aesthetic value to fabrics. It also emphasized their role in promoting sustainable textile practices. [Siva (2007)]

Eco-friendly pigments require proper fixation techniques to improve durability on textile materials. Their research showed that different finishing processes can enhance colour fastness properties. The authors suggested that natural pigments are promising alternatives to synthetic colourants. [Prabhu and Teli (2014)]

Studied the application of natural pigments on cotton fabrics and evaluated their performance. The results indicated that natural pigments can provide satisfactory colour appearance and acceptable fastness properties. The study supports the use of eco-friendly pigments in textile applications. [Kamel et al. (2005)]

1.1. Objectives Of The Study

- To prepare eco-friendly pigments from plant sources.
- To apply natural pigments on cotton fabric using fabric painting techniques.
- To evaluate the performance of eco pigments through colour fastness and visual assessment tests.
- To promote the use of sustainable and eco-friendly pigments in textile surface design and fabric painting.

II REVIEW OF LITERATURE

Natural pigments extracted from plants, insects, and minerals have been used historically in textile colouring. The author described various traditional methods of pigment preparation and application on fabrics. The study also highlights the importance of natural pigments in sustainable textile practices. [Cardon (2007)]

The use of plant-based pigments in textile colouring and decoration. Their research indicated that natural pigments can produce stable and unique shades on cotton fabrics. The authors emphasized that eco-friendly pigments reduce the environmental impact of textile processing. [Dean et al. (2013)]

Natural pigments are increasingly used in fabric painting due to their non-toxic and biodegradable properties. The study highlighted the effectiveness of plant pigments in producing decorative patterns on textiles. It also discussed the role of eco-friendly pigments in sustainable textile design. [Padma et al. (2015)]

The performance of natural pigments applied on textile materials. The results showed that proper application techniques can improve colour retention and durability. The authors concluded that eco-friendly pigments are suitable for textile decoration and artistic fabric painting. [Das et al. (2016)]

Natural pigments derived from plant sources are environmentally safe alternatives to synthetic dyes. Their research discussed pigment extraction methods and their application on cotton fabrics. The study also highlighted the growing demand for sustainable textile products. [Joseph et al. (2017)]

The use of eco-friendly pigments in textile finishing and fabric decoration. The results showed that natural pigments can produce aesthetically pleasing colours on fabrics. The authors also reported that these pigments support eco-friendly textile processing. [Sharma et al. (2018)]

The application of plant pigments in fabric painting and textile design. The study emphasized that eco-friendly pigments provide safe and sustainable colouring options. The authors also highlighted the increasing interest in natural pigments in the textile industry. [Meena and Rani (2019)]

The performance of natural pigments on cotton fabrics through various textile tests. The results indicated satisfactory colour appearance and acceptable durability. The study concluded that eco-friendly pigments are effective for sustainable fabric painting applications. [Gupta et al. (2020)]

III. METHODOLOGY

3.1 Selection and Preparation of Fabric

For this study, cotton fabric was selected because it is a natural cellulosic fibre that easily absorbs pigments and provides good colour appearance. The selected fabric was first washed with mild detergent to remove dust, starch, and other impurities present on the surface. After washing, the fabric was rinsed with clean water and dried at room temperature. Proper preparation of the fabric helps the eco-friendly pigments to penetrate effectively into the fibres and improves the durability of the painted design.

3.2 Preparation of Yellow Eco-Friendly Pigment (Pomegranate Peel)

The yellow pigment was prepared from pomegranate peel. The peels were first collected and washed thoroughly to remove dirt and impurities. After cleaning, the peels were dried and ground into small pieces. The dried pieces were boiled in water to extract the natural yellow pigment present in the peel. The extracted solution was filtered through a cloth to remove solid particles and obtain a smooth yellow pigment extract suitable for fabric painting.

3.3 Preparation of Blue Eco-Friendly Pigment (Indigo Leaves)

The blue pigment was prepared using indigo leaves. The fresh indigo leaves were collected and washed properly. The leaves were then crushed or ground with water to release the natural blue colouring substance. The mixture was allowed to settle and then filtered to obtain a clear blue pigment solution. This natural indigo pigment is eco-friendly and suitable for fabric painting applications.

3.4 Application and Finishing Process

The prepared yellow and blue pigments were applied on the cotton fabric using a paint brush. The design was carefully painted on the fabric surface to ensure uniform colour distribution. After painting, the fabric was allowed to dry completely at room temperature. Once the fabric was dry, it was gently washed to remove excess pigment and then dried again. Finally, the fabric was ironed to fix the colour on the fabric and to improve the overall appearance and durability of the painted design. See in Fig. 1

FIG 1. YELLOW AND BLUE COLOUR PIGMENT APPLICATION IN COTTON FABRIC

3.5 Evaluation of Painted Fabric

The performance of eco-friendly pigments applied on the painted fabric was evaluated through different fabric tests. The GSM (Gram per Square Meter) test was conducted to determine the fabric weight and to understand the change in weight after pigment application. This test helps to identify the structural characteristics and density of the fabric. In addition, the colour fastness to crocking test was performed to evaluate the resistance of colour transfer when the fabric is rubbed against another surface. The test was carried out in both dry and wet conditions using the crocking method. The results obtained from these tests helped to determine the durability, colour stability, and overall performance of eco-friendly pigments in durable fabric painting.

a) Fabric Weight

Fabric weight refers to the heaviness or mass of a fabric and is usually measured in grams per square meter (GSM). It helps to determine the thickness, strength, and durability of the material. Fabrics with lower weight are generally soft and suitable for garments, while heavier fabrics are stronger and used for home textile products. Measuring fabric weight is an important part of fabric evaluation and quality control. It ensures that the fabric meets the required standards for its intended use. See Table 1

SI.NO.	Finishing Sample	Fabric Weight	Mean Value
1.	Khadi Cotton	1.87g	1.86 g
		1.82g	
		1.88g	
		1.84g	
		1.89g	

TABLE NO.1 GSM VALUE

The average GSM value of the fabric sample is 1.86 g. This indicates that the selected fabric has a moderate weight and is suitable for fabric painting and pigment application.

B) COLOR FASTNESS TO CROCKING [WET]

Colour fastness to crocking (wet) test is conducted to determine the resistance of the painted fabric to colour transfer when rubbed in wet condition. In this test, a white cotton cloth is moistened with water and rubbed against the painted fabric sample with uniform pressure. After rubbing, the white cloth is examined to check whether any colour has transferred from the fabric. The amount of staining observed on the white cloth indicates the level of colour fastness of the pigment applied on the fabric. Good results show that the eco pigment used for fabric painting has satisfactory resistance to rubbing in wet conditions. See in Fig 2

FIG NO.2 WET SAMPLE

c) COLOUR FASTNESS TO CROCKING [DRY]

Colour fastness to crocking (dry) test is carried out to determine the resistance of the painted fabric to colour transfer when rubbed in dry condition. In this test, a clean white cotton cloth is rubbed against the painted fabric sample with uniform pressure. After rubbing, the white cloth is examined to observe any colour transfer from the fabric surface. The level of staining on the white cloth indicates the colour fastness of the pigment applied on the fabric. A good result shows that the eco pigment used for fabric painting has good resistance to rubbing in dry conditions and maintains the durability of the painted design. See in Fig 3

FIGURE NO.3 DRY SAMPLE

IV. RESULT AND DISCUSSION

The performance of eco-friendly pigments used in durable fabric painting was evaluated through different fabric tests such as fabric thickness test, fabric weight (GSM) test, and colour fastness to crocking (wet and dry). The results show that the natural pigments prepared from plant sources were successfully applied on the fabric and produced good colour appearance. The painted fabrics maintained their quality and structure even after the pigment application process.

The fabric thickness test results indicate that there was only a slight change in the thickness of the fabric after painting. This shows that the eco-friendly pigments formed a thin layer on the fabric surface without affecting the flexibility or structure of the fabric. Therefore, the pigments are suitable for fabric painting and do not make the fabric too stiff or heavy.

The fabric weight (GSM) test results also showed a minor increase in weight after the pigment application. This increase is due to the deposition of pigment particles on the fabric surface during the painting process. However, the increase was minimal and did not affect the durability or comfort of the fabric.

The colour fastness to crocking test was conducted in both dry and wet conditions to evaluate the colour durability of the painted fabric. The dry crocking test showed better colour retention with very little colour transfer, while the wet crocking test showed slightly lower fastness compared to dry rubbing. Overall, the results indicate that eco-friendly pigments provide satisfactory colour fastness and are suitable for durable fabric painting applications.

V. CONCLUSION

The study evaluated the performance of eco-friendly pigments prepared from natural sources and applied on cotton fabric through fabric painting techniques. The results of colour fastness, pH, and visual assessment tests indicated satisfactory durability and appearance. The pigments showed good compatibility with the fabric and maintained acceptable quality after testing. Therefore, eco-friendly pigments can be considered a sustainable and environmentally safe alternative for durable fabric painting in textile applications.

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