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Comparative Analysis of Dyeing Properties on Unbleached and Bleached Cotton Knitted Fabrics Using Bougainvillea Flower (*Bougainvillea glabra*) Extract: A Sustainable Approach to Textile Dyeing

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ABSTRACT

The use of bougainvillea flowers as a natural dye for cotton knit textiles is investigated in this study. Comparing fabrics that have been bleached and those that haven't, it emphasizes colorfastness and coloring parameters. Additionally, the study assesses how substrate bleaching affects dyeing effectiveness and final color look. The study highlights the environmental friendliness and potential for sustainable textile dyeing techniques of bougainvillea flower, offering insights into its dyeing performance and sustainability as a natural dye for cotton textiles.

Key Words : Natural dye, Cotton Knitted, Bougainvillea Flower Extract, Unbleached, Bleached, Sustainable

INTRODUCTION

Growing awareness among people for ecological balance has created a demand for natural products even in the field of textiles (Deo and Sarkar, 2008). We use dyes a lot in our daily lives. Both synthetic and natural colors are fascinating substances. In several industries, dye is used to print on or color materials such as leather, paper, and textiles. Certain colors irritate the skin and eyes, cause harm, and are carcinogenic. Even with organic fabric, there is a lack of openness regarding the quality of the chemicals and dyes used in the printing and dying of textiles, making it challenging to find really sustainable fabric (Choudhury, 2018).

It is currently illegal to use many of the artificial colors that cause allergies and cancer. Using natural colors derived from plants, animals, and minerals was standard practice before synthetic dyes were created (Affat, 2021). The time to identify methods to add value to agricultural waste and byproducts that are burned or utilized in wasteful ways has come. Because they are biodegradable, natural resources derived from plant components preserve ecological equilibrium (Jose *et al*., 2019). Prioritizing research on natural dye applications would help the processing sectors make more money by repurposing agricultural waste (Hazarika *et al.,* 2017).

The textile industry's fabric production process is increasingly relying on sustainable and eco-friendly processes (Pandey *et al*., 2018). The most popular fabric for clothing is cotton. In addition to aesthetic appeal, modern consumers are also concerned with the practicality of materials (Pandit *et al*., 2020). There has been a lot of interest in using natural dyes generated from unexpected sources to replace synthetic colors in this circumstance (Dutta *et al*., 2021).

The ultimate color outcomes of unbleached cotton fabric can be influenced by inherent flaws and pigments (Daberao *et al*., 2016). A frequent canvas for dyeing

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experiments, on the other hand, is bleached cotton cloth, which undergoes a process to remove impurities and offer a neutral base (Roos *et al*., 2015). Selection between fabrics that have been bleached or not can be a big influence on the dyed textiles' generally their quality, color fastness, and final look.

The selection of bougainvillea flower as a source of natural dyes adds an interesting dimension to the study (Rasool *et al*., 2023). The often-discarded bougainvillea flower has bioactive ingredients that may one day be used as natural colorants (Singh *et al.,* 2008). This ecologically friendly strategy is in line with the textile industry's increasing desire for green practices (Yeasmin *et al.,* 2018).

In natural dyeing methods, mordants are essential because they improve color retention and the general functionality of colored materials (Prabhu *et al*., 2012). In order to examine its impact on the dyeing properties of both unbleached and bleached cotton knitted textiles, this study uses citric acid, a mild and biodegradable mordant. The eco-friendly goals of reducing the dyeing process's negative environmental effects are in line with the usage of citric acid as a mordant. Eco-friendly production methods save water as well (Sarkar *et al.,* 2023).

With the use of natural dyes derived from bougainvillea flowers, this comparative study seeks to provide important new understandings into the dyeing characteristics of knitted cotton textiles that have been bleached and unbleached (Sabaraudin *et al.,* 2016). A crucial quality criterion for evaluating dye and dyeing is the materials' fastness (Deo *et al.,* 2010). Certain types of textile fibers are not compatible with all dyes. The results may clarify the viability of using unusual sources for natural dyes and the influence of choosing the right mordant on the properties of the finished cloth. Furthermore, by advocating a balance between aesthetics, environmental responsibility, and product quality, the research aims to highlight the potential for the textile sector to embrace sustainable methods.

METHODOLOGY

Fabric:

Jet Knitwear in Kanpur was the source of the cotton knitted single jersey fabric. For the investigation, single jersey 100% cotton unbleached and bleached fabric material were used. Before dying, the fabrics were scoured with a non-ionic detergent.

Extraction of Bougainvillea Flower Dye and Dyeing of Textiles:

Initially, the bougainvillea flowers were ground into a rough powder. In order to extract the dye at 80°C for 60 minutes, 4 grams of dye material were boiled in 100 milliliters of water to create the dye solution for 1 gram of cloth. After that, the dye extracts were cooled and filtered. Lemons were pressed to extract their citric acid, which was then used in the simultaneous mordanting technique. A mixture of 1 ml citric acid and 100 ml extracted dye solution was made in advance for 1 gram of cloth. One gram of cloth was immersed in a dye solution for sixty minutes at 80°C. After letting the samples cool, they were gently squeezed, cleaned with water, and then flat-dried in the shade.

Serviceability Tests Performed on Dyed Samples:

Fabric Strength:

The samples were dyed, and then their strength was measured to see if this had an impact on it. Using a tensile strength tester, the test was conducted.

Fabric Thickness:

A thickness tester was used for this test. A micrometer included in the tester was used to measure the thickness of the fabric after the specimen was pressed by the circular pressure foot. Using the previously described methodology, each test specimen was randomly positioned three times before being examined one at a time. All of the results were averaged. The thickness of the cloth is stated in millimeters.

GSM (Gram per Square Meter):

To perform the GSM test, a 10x10 cm swatch cutter was used. For every sample, three swatches were cut out and put on an electronic weighing scale. The gram per square meter of the cloth was calculated by multiplying the measured weighing quantity by 100.

Analysis of the color value of dyed samples:

A data color spectrophotometer was used to measure the color coordinates and color strength (K/S) value of the dyed samples based on the CIE Lab system.

Fastness properties of dyed fabrics:

The dyed samples were assessed for washing

fastness, rubbing fastness (both wet and dry), and light fastness in accordance with IS: 3361:79, ISO-105-X12, and ISO 105-BO2:2002 standards, in that order. The color fastness is rated on a grey scale. A higher score denotes improved fastness (for instance, a 5 score means there was no color change after the fastness test, but a 1 score denotes inadequate fastness). With the exception of light fastness, which is graded between 1 and 8, all grades fall between 1 and 5.

RESULTS AND DISCUSSION

Physical testing of dyed fabric:

Physical factors such as fabric strength, thickness, and GSM were examined in order to compare unbleached and bleached, colored, and undyed textiles. In Table 1, measured values are displayed.

Fabric Strength:

Kilogram-force was the unit of measurement for fabric strength. The strength of unbleached and bleached cotton knitted dyed fabric is reported in Table 1. Results indicate unbleached dyed fabric and bleached dyed fabric has same strength values.

Fabric Thickness:

Dyeing caused an increase in fabric thickness. Unbleached dyed cloth (22mm) has a greater thickness than bleached dyed fabric (21mm).

GSM:

The weight of 165 grams per square meter of unbleached colored fabric falls into the medium weight category, whereas 148 grams per square meter of bleached dyed cloth is classified as lightweight. It is evident from the comparison that the unbleached dyed fabric has a higher GSM value than the bleached dyed fabric.

Computer Color Matching:

Computer color-matching software was used to assess the dyed samples for their color values. Table 2 shows that the L* value represents the shade depth, a* value indicates the shade's tone in the greener or redder area, the b* value indicates the shade's tone in the yellow or blue region, and the K/S value reflects the dyed fabric's overall color value. In contrast to bleached dyed cloth (3.74), unbleached dyed fabric has a higher K/S value (4.1), indicating that it has more color. The L* value in the dyed samples is greater than expected, indicating that there is less dye absorption and a lighter hue (75.29 for bleached samples and 75.29 for unbleached samples, respectively). The unbleached fabric that was dyed had a higher value of a* (6.11), indicating a redder tone, than the bleached dyed fabric (5.92). The bluer tone was present in the unbleached colored sample with the highest b* value (19.16). Likewise, the bleached dyed fabric produced the lowest b* value (17.98). The bluer tone was present in the unbleached colored sample with the highest b* value (19.16). Likewise, the bleached dyed fabric produced the lowest b* value (17.98). Unbleached dyed knit fabric had the greatest K/S value (4.1), whereas bleached dyed knit fabric had the lowest (3.74). There is a difference in the color strength (K/S) value of the unbleached and bleached dyed fabrics.

Color Fastness Analysis:

The fastness data for the colored cloth is shown in Table 3. In the case of the colored samples, the unbleached

Table 1 : Comparison among the unbleached and bleached dyed fabric based on physical parameters

Tests	Unbleached Fabric		Bleached Fabric	
	Undyed	Dyed	Undyed	Dyed
Fabric Strength	12 kgf	11 kgf	10 kgf	11 kgf
Fabric Thickness	20 mm	22 mm	18 mm	21 mm
GSM	147 gm	165 gm	129 gm	148 gm

Table 2 : Computer Color Matching Data

Fabric	L*	a*	b*	K/S
Unbleached	82.88	3.02	14.17	0.78
Bleached	85.24	3.16	-8.09	1.43
Dyed (Unbleached)	75.17	6.11	19.16	4.1
Dyed (Bleached)	75.29	5.92	17.98	3.74

Table 3 : Fastness Properties of Bougainvillea Flower Extract Dyed Knit Fabrics

Fabric	Rubbing Fastness		Washing Fastness	Light Fastness
	Wet	Dry		
Unbleached	3/4	4/5	4	8
Bleached	3/4	5	4	8

and bleached dyed cotton knitted fabric received a washing fastness grade of 4. This shows that the cloth has the color securely bonded to it. The reported work light fastness grade of the dyed knit fabric samples, both bleached and unbleached, in direct sunshine is 8. This demonstrates the dye's outstanding affinity for the cotton cloth and its good light fastness. Good findings were obtained when comparing the rubbing fastness of unbleached dyed fabric (4/5 and 3/4 for wet rubbing and 5 for dry rubbing), and unbleached dyed fabric (4/5 and 3/4 for wet rubbing and 5 for dry rubbing).

Conclusion:

Conclusively, the comparative analysis conducted on cotton knit fabric dyed with bougainvillea flower and bleached and unbleached fabrics has yielded significant insights into the possibilities of natural dyeing techniques.

More vivid colors are possible because of the superior substrate provided by the unbleached cotton when using bougainvillea flower dye. Since unbleached cotton is made from natural fibers, it retains its original strength and texture, making the cloth more visually appealing and more durable. Utilizing bougainvillea flower as a dye source also has a far smaller environmental effect than utilizing conventional bleaching methods. Reduced ecological impact and less water pollution are two benefits of doing away with harsh chemicals from the dyeing process. The increased emphasis on ecologically friendly techniques in the textile sector worldwide is in line with this sustainable strategy. Excellent colorfastness to light (8) and washing (4) was shown by the colorfastness and overall performance of the unbleached colored cloth. Dye affinity was same in unbleached and bleached fabrics.

In conclusion, the study highlights the potential of bougainvillea flower as an eco-friendly and sustainable option for the textile industry by proving that it is a feasible natural dye for cotton garments. The comparative examination of fabrics that have been bleached and those that have not offers important information to help researchers implement greener dyeing techniques. Further research might focus on improving dying conditions, looking into new uses, and determining if it would be financially feasible to produce bougainvillea flower dye on a bigger scale.

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