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Studies on the Effect of Pigment Dye on Printed Jute and Jute Blended Dyed Fabrics

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A B S T R A C T

Eco-friendly jute cotton blended fabric that has been chemically treated and then printed with pigment dyes using a thickener makes printed jute cotton blended fabric that can be used for a variety of different value-added purposes. A process called "pre-treatment" is used to make the fabric more absorbent of the color printing paste. In the standard recipe, the amount of fabric to color was kept at 10:1 (wt./wt.). The chosen design was printed on the blended fabric using screen-printing technology. The pigment color's particles ranged in size from 300 to 400 nm. Evaluation of these printed fabrics reveals that the printed jute fabric rubs very quickly and has higher stiffness than the grey fabric. Utilizing a substantial screen-printing technique, this printed fabric can be created from chemical thickeners and pigment dyes for use as textiles for apparel, home décor, and furnishings

Keywords: blended fabric; pigment dye; rubbing fastness; stiffness; screen printing.

1. Introduction

Jute fiber contains three major classes of chemical compounds, namely cellulose (58-63%), hemicellulose (20-24%), and lignin (12-15%), as well as small amounts of fats, pectin, and aqueous extract [1]. Conventionally, jute fiber is not utilized for the production of wearable textiles due to its deficiencies in touch, stiffness, drape, coarseness, washability, and abrasion resistance. Blending jute and cotton is a method for overcoming the negative qualities of each fiber [2]. It is a technique for combining fibers that emphasizes the fiber's good qualities while minimizing its flaws. It also makes the fabric manufacturing process more cost-effective [3]. Another diverse application for increasing economic acceptance and value-added products is printing on jute fabric. Printing is the application of color to fabric in specific patterns or designs. When fabrics are printed correctly, the color is bonded with the fiber, which allows it to withstand friction and washing. Textile printing is related to dyeing, but the difference between the two processes is that when dyeing is done correctly, the entire fabric is covered in a single color uniformly, whereas when printing, one or more colors are applied to it in certain parts only, and in patterns that are very clearly defined [4]. Jute cotton blended fabrics are printed using a variety of natural and synthetic dyestuff, including basic, reactive, pigment, and vat (synthetic). Some examples of natural dyestuff include annatto (Bixa Orellana), ratan jot (*Onosma echoides*), turmeric powder, and catechu. Synthetic dyestuff includes basic, reactive, pigment, and vat (*Senegalia catechu*) [5].

Pigments have become the most common way to print on fabric because it is the oldest, easiest, and cheapest way to do so [6]. It can also be used with almost any kind of fiber or blend. On the other hand, insoluble pigments don't like the fibers, so they can't easily be absorbed by the fibers and stuck to them. So, binders are used to make the pigments stick to the fibers. Binders can be made from acrylics, styrene-butadiene, styrene-acrylate, or vinyl acetate-acrylate polymers and copolymers [7]. The fastness of the pigment printing and the quality of the binder are two characteristics that define high-quality pigment printing. In point of fact, pigment binders play a significant role in the process of pigment printing because of their ability to enclose pigment particles and adhere to fibers [8].

Today, pigment printing has reached a high technical standard, which, when combined with its straightforward and cost-effective process (which does not require washing-off), gives it a leading position and widespread acceptance among the various classes of dyes that can be used in printing systems. Pigment printing accounts for approximately half of the world's total textile print production, or approximately 8000 million m^2 as of right now [9]. In some nations, the percentage of pigment printing is relatively high, while in others, it is relatively low. Countries can be categorized according to this factor. This first group consists of the United States of America (approximately 70%) and the Soviet Union (below 10%). The large quantities of polyester/cotton blends that are produced in the United States are primarily responsible for the high percentage of pigment printing that occurs there; this type of printing accounts for as much as 95% of the total [10].

Jute fibers, in general, have a difficult time adhering to pigment printing paste, and there has not been a report written about the various effects that pigment printing can have on jute-cotton blended fabric. This is a problem. The purpose of this research was to investigate the effect of pigment color on blended fabrics made of jute and cotton by carrying out a number of experimental procedures that were grounded in both physical and mechanical testing.

2. Materials and methods

Materials:

A plain weave grey jute/cotton blended fabric (Fig. 1) with the following specifications was used:

Warp: 48 ends/inch (Count, 32 Ne)

Weft: 38 ends/inch (Count, 32 Ne)

Fabric mass: 150 g/m2 (at 65% RH, 27°C)

Chemicals

The following chemicals of analytical grade were used in the experiment.

Sodium Hydroxide (NaOH) 4 gm/L, Sodium Chloride (NaCl) 1 gm/L. Hydrogen Peroxide (H2O2) 8 gm/L, Sodium Silicate (Na2SiO3), Acetic acid (CH3COOH) 0.2 gm/L, Binder and softener.

Mordants

Chemical Mordant: Potash alum (Hydrated salt of potassium aluminum sulfate)

Dyes

Pigment Red 1 was used as a dyestuff for this pigment printing (Fig. 2)

Figure 1: Jute cotton blended grey fabric

Figure 2: Pigment printed fabric.

Thickener

Sodium Alginate ($NaC_6H_7O_6$) was used as a thickener.

Methods

Singeing & Desizing

The small fibers of the jute/cotton fabric were burned off during the singeing process, which made the surface of the fabric smooth. Desizing: Take the materials used to size the fabric away.

Scouring and Bleaching

The scouring process gets rid of wax particles, dirt, and fats, and it also makes the fabric more water-friendly. Lastly, the fabric is bleached to remove its natural color and get it ready for printing.

Mordanting

Bleached fabrics made of a mix of jute and cotton were treated with potash alum (10% owm) at 80°C for 30 minutes. The ratio of material to liquor was kept at 1:20. The fabrics made of jute and cotton that have been treated with a mordant are dried without being washed so they can be printed on with pigment dye red 1.

Preparation of the print paste

The pigment printing paste was made with water that had been distilled, 3% pigment dye, 5% thickener, 9% binder, and 9% fixing agent. After the paste was mixed well, it was put on the fabric using the screen-printing method.

Printing of jute cotton blended fabric

The blended fabric was printed by hand using a process called screen printing. Samples of jute/cotton fabrics that had only been bleached and those that had also been treated with a mordant were put on a printing table. By making four strokes with a rubber squeeze, the print paste was put on the fabric through nylon screens. The pattern is repeated 1 time. The samples were then dried and steamed for 30 minutes at 100°C.

Crocking Fastness

Crocking is the process of transferring color from printed fabric to another fabric surface via rubbing. James heal electronic crock meter (Fig. 3(a)) was used to determine the resistance of printed fabrics to dry or wet rubbing. The colorfastness to rubbing was determined by applying 20 greyscale (staining) strokes. The result of the test is shown in table 1.

Figure 3: a) Schematic diagram of rubbing fastness tester b) Stiffness tester

Stiffness test

The grey fabric and the sample with the pigment print were cut to the 4x4-inch ASTM-D 4032 standard. The sample is then put through a machining process (Fig. 3(b)) to measure how stiff both types of fabric are. The results of the test are shown in Table 2.

Drape Coefficient Test

The Cusick drapometer (Fig. 4 (a)) was used to measure the fabric's drape coefficient. Before testing, three samples of fabric were put in a standard environment with a relative humidity of 65% and a temperature of 20.2°C. This is what BS 1051 says to do. The British standard for judging how fabrics hang (BS 5058) talks about a way to use the "Drapemeter." A circle with a diameter of about 0.3 m is held up by a circle with a diameter of 0.18 m. Some folds may form in the area that isn't being held up. The number of folds (nodes) is a direct way to describe how well something can be draped. The fabric is smoother where there are more nodes. The area of the supporting disk can be found by dividing the projected area of the fabric sample by the area of the sample when it's not stretched. This is called the drape coefficient.

Drape coefficient = (area of shadow – area of supporting disk)/(area of shadow – area of supporting disk)*(the area of the circular specimen – the area of the supporting disk)

The fabric gets stiffer as the drape coefficient goes up.

Bursting strength Test

The bursting strength tester (Fig. 4 (b)) measures the maximum force needed to cause a material to collapse when a force is applied to it while it is resting on a rubber diaphragm. Between two annular clamps, a test specimen is held securely enough to prevent slippage. The lower clamping surface has several concentric grooves, while the upper clamping surface, which is in contact with the test specimen, has a continuous spiral groove. A circular diaphragm made of pure gum rubber is clamped between the lower clamping plate and a pressure cylinder. Before the diaphragm is stretched by pressure from below, the center of its upper surface is below the plane of the clamping surface. A 90 mm by 90 mm test sample was placed on the lower clamp so that the area to be tested was in the middle. The machine was turned on and run until the test sample broke.

a)

b)

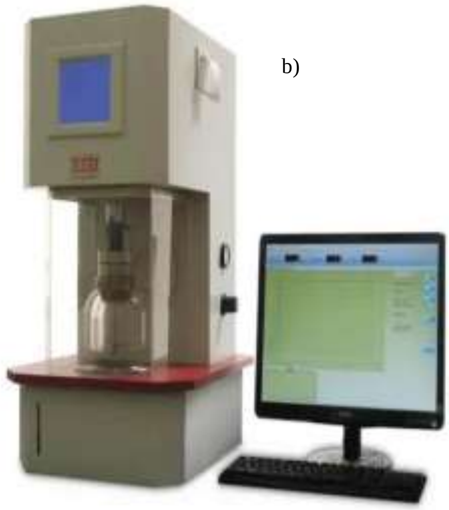

Figure 4: a) Drape tester b) Bursting strength tester

3. Results and Discussion

The physical properties like rubbing fastness, stiffness, drape co-efficient, bursting strength and tearing strength were measured in both grey fabric and printed fabric.

Study on rubbing fastness

In this study, grey and printed fabrics were put through a crock meter machine (Fig. 3) to test how well they held up to rubbing in both wet and dry conditions.

Table 1. Rubbing fastness test results in a dry and wet medium

Rubbing Fastness	Grey Fabric (grading)	Printed Fabric (grading)
Dry Scale	1. 5	2. 4/5
Wet scale	3. 5	4. 3
Cycle	5. 20	6. 20

Figure 5 demonstrates that the grey fabric is better at keeping its color in both mediums (dry and wet). The level of rubbing fastness was 5, which is a very good level for under 20 cycles of rubbing stroke. On the other hand, the pigment printed on wet medium (level 3) doesn't work as well as it does on grey fabric. It could happen because the crocking cloth has moisture in it. When wet, the coefficient of friction is almost twice as high as when dry. So, the ratings for wet rubbing of the same sample are always worse than the ratings for dry rubbing. We know that the way a color stays true depends on the type of dye used, the shade, the depth of the shade, and the way it was dyed. In a dry environment, the colorfastness of the fabric was very good (level 4/5).

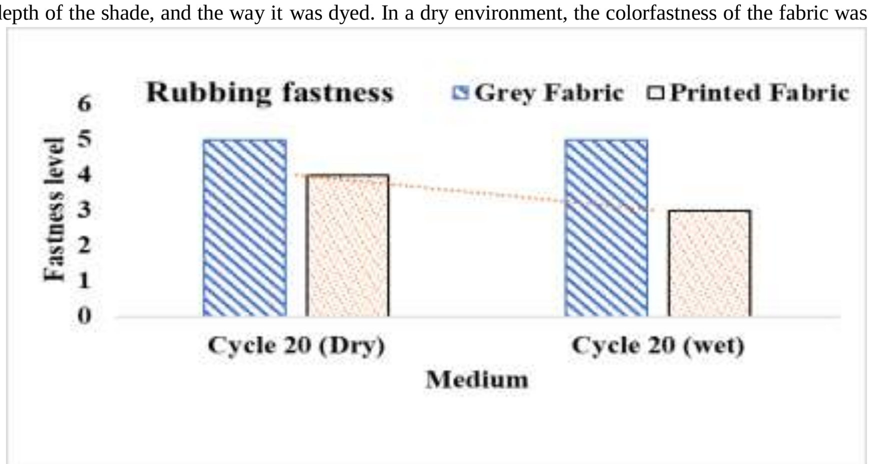

Figure 5: Rubbing fastness properties of grey fabric and printed fabric

Study on Stiffness

In this study, the stiffness test was done on both medium-weight grey fabric and pigment-printed fabric. The rigidity of an object is its stiffness, which is how much it resists changing shape when a force is applied. It gets bigger as the bending strength gets bigger. The stiffer something is and the less it falls, the more bending strength it has.

Table 2. Stiffness test results in dry & wet scale

Stiffness test	Grey Fabric stiffness (cN)	Printed Fabric stiffness (cN)
Dry scale	7. 11.1	8. 53
Wet scale	9. 14.4	10. 46
Dry scale	11. 13.3	12. 48
Wet scale	13. 12.2	14. 49
Average	15. 12.64	16. 49

Figure 6 shows that compared to grey fabric, the pigment-printed sample has the highest stiffness strength both when it is dry and when it is wet. The average bending strength of a sample of fabric with pigment prints is 49 cN, which is very high. On the other hand, the grey fabric has a very low average bending strength (12.64 cN) and is also not very stiff. It could have happened because the grey fabric absorbs the color compound when it is printed, making the fabric rougher and heavier. It is the best result for a pigment-printed sample that can be used for many different things.

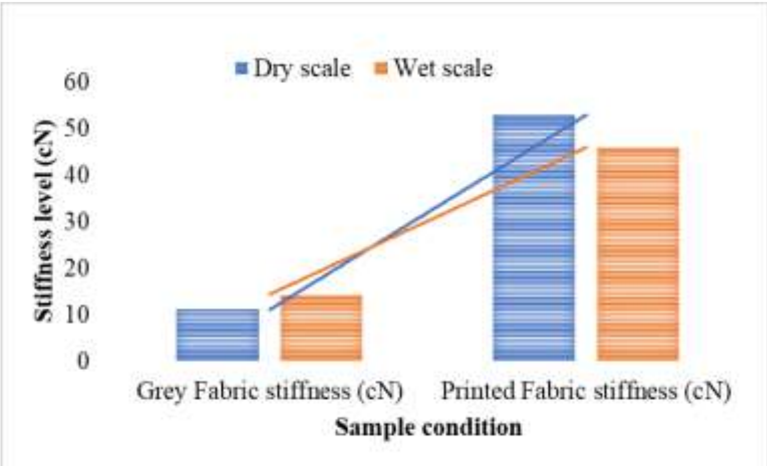

Figure 6. Stiffness test properties of grey fabric & pigment printed fabric

Study on Drape co-efficient

According to the definition of drape coefficient, higher the drape coefficient, the stiffer the fabric. It can be observed from the figure 7 that pigment printed fabric drape coefficient is higher (78) compared to grey fabric (45). The pigment printed sample is the most stiffer because the printed recipe includes the binding agent.

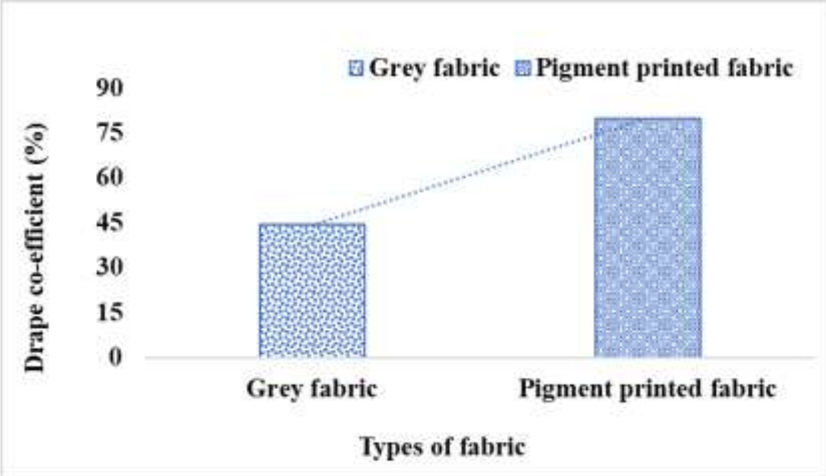

Figure 7. Drape co-efficient (%) of grey fabric and pigment printed fabric

Study on Bursting Strength

Figure 8 shows that bursting strength also higher in the case of pigmented printed sample. Chemical modification of jute cotton blended fabric turned into a ridiculous change compared to grey fabric.

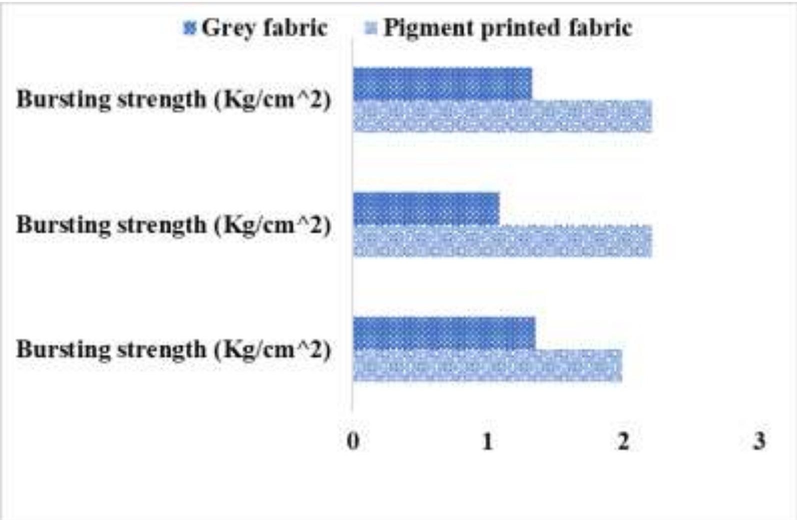

Figure 8. Bursting strength of grey fabric and pigment-printed fabric

Study on Tearing Strength

According to ASTM D1682, tearing strength is the amount of force needed to begin or continue tearing a fabric in either the weft or warp direction under given circumstances. A fabric or garment tear can be started by a moving fabric getting caught on a sharp object, and it typically develops gradually along a line. Figure 10 illustrates that pigment-printed fabric tearing strength is clearly higher than the gray fabric because the pigment-printed color is the form of excessive use of binder (binding agent) which makes it more stronger in both directions (warp & weft). Three samples were tested to observe the pigment printed tearing strength and found similar findings compared to grey jute cotton blended fabric.

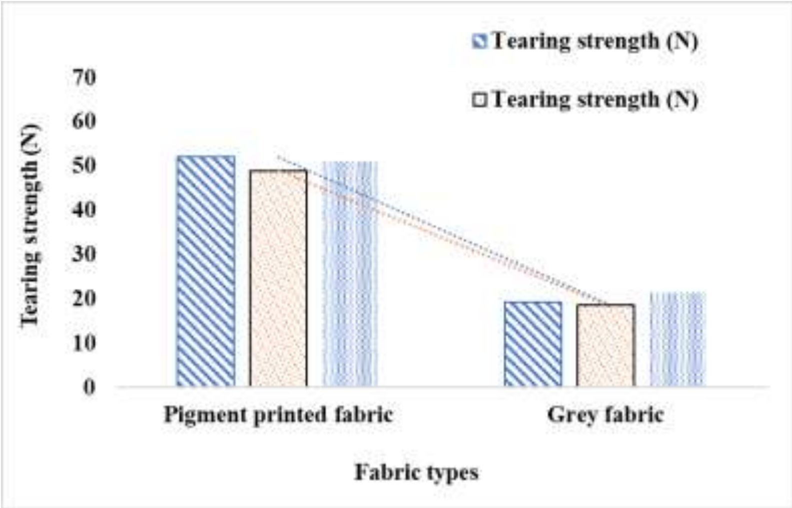

Figure 9. Tearing strength of grey fabric and pigment-printed fabric

4. Conclusion

The color fastness, stiffness, drape co-efficient, bursting strength, and tearing strength of a jute-cotton blend fabric were tested in both cases pigment printed sample and grey fabric. It was found that the grey condition of the fabric has very good (level 5) colorfastness properties in both dry and wet conditions. On the other hand, the pigment-printed fabric has good (level 4) colorfastness properties in dry conditions, but worse in wet conditions (level 3). In the stiffness test, it was found that the pigment-printed fabric is stiffer (by an average of 49 cN) than the grey fabric (Avg. 12.64 cN). The drape coefficient, bursting strength, and tearing strength also found that pigment printed sample is higher compared to grey fabric. Finally, in this research achievement can be concluded that pigment-printed fabric can be used in the application of diversified products.

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