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(RESEARCH ARTICLE)



# Studies on the effect of reactive dye on jute and jute blended fabrics

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## Abstract

Jute is generally not dyed with reactive dye though it is a cellulosic fiber. While jute is dyed with basic dye, but cotton, viscose, and other cellulosic fibers are frequently dyed with reactive dye. In this study, a novel method for dying blended jute fabrics with reactive dye after bleaching them is presented. Two different reactive dye colors were used to treat this blended jute fabric. By contrasting samples of non-dyed grey blended jute fabric, the GSM, Water uptake percentage, and FTIR of dyed fabric were examined. It has been observed that the dyed sample's GSM (average 76) is higher than the grey fabrics GSM (average 65) due to the chemical modification of grey blended jute fabric. Blended jute fabric has a lower water absorption percentage while dyed sample has a higher absorption percentage such as 150% in 40 min and 145% in 140 min. Due to chemical modification of the surface of the blended jute fabrics, the FTIR spectrum report reveals that –OH group peak appeared in the wave number of 3291 cm−1 and the dyeability of the fabric is significant based on peak analysis.

**Keywords:** Blended fabrics; GSM; FTIR; Water uptake; Reactive dye

## 1. Introduction

Coloring jute fabric has become important for all kinds of fabrics; from those with added value to those used for packaging. Because jute fibre is good for the environment and biodegrades; the demand for jute fabric is growing around the world every day [1]. Blending is a way to improve on the weak points of a fiber. It is the way that fibers are put together that shows off their good qualities and hides their bad ones. It also makes the process of making fabric go more quickly [2]. One example is yarn made from a mix of jute and cotton. Adding cotton fiber to jute to make goods with more value may be a good way to diversify the use of jute. Jute fibers' good qualities; high tenacity; and lustrous golden appearance are just a few of their advantages. Therefore; by using blending and softening techniques; jute's quality could be enhanced; leading to the development of a new class of jute-based fabrics with an expanding market both within and outside of the country. The issue can be a little bit more manageable by combining cotton and jute. However; the blended fabric; particularly when the amount of jute is high in the blend; does not satisfy the specifications for clothing or home decor fabrics on its own [3].

Since jute fabric is good for the environment; reactive dyes are the best way to color it. Reactive dyes have been used to color jute in a number of studies. With reactive dyes; the dye reacts with the hydroxyl group of the fiber by either replacing it or adding to it [4]. During their use; along with the dye being absorbed; the dye is also broken down by the water. The hydrolyzed dye stayed on the fabric; and it has to be washed very hard to get rid of it. This makes dye go to waste. When the pH is higher; water breaks down the dye more quickly. Even the less reactive dyes start to break down over time in an alkaline environment; even if it takes a long time. This makes a dye effluent with a lot of color; which is

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bad for the environment. Also; since reactive dyes are becoming more and more popular; the high concentrations (40–80 g/L) of electrolyte and alkali (5–20 g/L) needed for dyeing may cause more effluent problems [5]. The problems that reactive dyeing causes for the environment are also getting worse. Because of this; it is important to use reactive dyes well and fix them on fibers [6-7].

Numerous studies have focused on enhancing the substantivity of cellulose for reactive dyes in order to reduce or eliminate the need for electrolytes and boost the effectiveness of dye-fibre interaction. Jute fiber is typically colored using basic dye in a mildly acidic medium [8]. The cellulose was degraded by acid; which could lead to a reduction in jute fiber strength. Furthermore; it takes a long time to dye jute with basic dye; and many basic dyes take a long time to fade in the presence of light; washing; acids; and alkalis [9]. Again; the color spectrum that can be achieved with basic dye is not as wide as that of reactive dye; which is a popular dye for dying cellulose. Reactive dyes are the most popular way to color cotton goods around the world because they are easy to use; inexpensive; have bright colors; and don't run when they get wet. But the reactive dye isn't usually used to color jute; even though it is made of plant fibers. Reactive dyeing of jute is not cost-effective because it has a high degree of crystallinity and orientation; which makes it hard to get a high color yield. Again; the dye doesn't wear out as quickly because there is less cellulose (58%–63%) than there is cotton (94%) [10]. It is not possible to make the fiber have more cellulose. But it makes sense that increasing the percentage of dye sites in the fiber would help the dye run out faster in jute fiber. Adding cationic sites to the cellulose is a good way to increase the dye's ability to stick to it. Either ammonization or cationization can be used to add cations.

Since all of them have one or more drawbacks; such as significantly reduced light fastness; subpar dye fixation efficiency or poor wet fastness; noticeable color change; limited suitability of the treatments for various types of reactive dyes; unpleasant odors released during the application; etc.; none have; to date; seen significant commercial success. The use of reactive dyes by conventional application techniques is complicated by numerous dyeing process variables that obstruct accurate shade reproduction. Dyeing hydrolysis; or the reaction of dyes with water; is the biggest issue because it obstructs the reactive sites; making it impossible for the dyes to form covalent bonds with fibers. With repeated use; chemical buildup or salt accumulation can increase or decrease dye bath exhaustion and fixation. When acid is added to the dye bath to lower the pH before each reuse; salt is created.

It is possible to increase the hydroxyl group for the formation of a covalent bond with a reactive dye and to reach the desired level of exhaustion by using various bleaching techniques on blended jute fabrics. The dyeability and color performance of treated blended jute fabric dyed with reactive dye was examined in the present study; and the outcomes were compared with those of the grey fabric. Not much research has been associated based on reactive dye in jute cotton blended fabric. Previously; basic dye was applied on pure off white bleached jute fabric but the washing fastness was found very poor level. In this study the result and findings will be the new research addition in the field of blended jute fabric as a application of reactive dye.

## 2. Methodology

### 2.1. Materials

*2.1.1. Sample Preparation*

All of the tests used 30/70 jute cotton blended fabric (70 GSM) that had been cleaned and bleached (Fig.1). Before dying; the fabric samples were treated with a 4 g/l solution of caustic soda for 20 minutes at 90°C. Then; they were neutralized with a solution of acetic acid. A solution for bleaching was made so that the blended fabric could be whitened. The samples of fabric were then put in this solution for 60 minutes at 60°C; squeezed to get rid of any extra solution; and dyed.

**Figure 1** Grey-Blended Fabric

*2.1.2. Reactive dyeing of jute fabric*

Two distinct types of reactive dyes were employed to dye the bleached blended jute fabric: rose reactive dye and yellow reactive dye. The traditional procedure for dyeing bleached blended jute fabric involved utilizing all of the reactive dye and fixing it with alkali in the same bath. During this process, one bath used up all of the reactive dye, while another bath utilized alkali to fix it.

**Methods**

*2.1.3. Dyeing with reactive dye (yellow and Rose colour)*

The salt bath (60 g/L) was used to soak the bleached jute fabric for 30 minutes with a material to liquor ratio of 1:20. After adding the dye to the bath; the procedure went on for an additional 30 minutes. The pH of the bath where the dye bath was used and checked dye absorbency. Following the exhaustion stage; 20 g/L sodium carbonate was added for dye fixation and left at room temperature for 45 minutes. After a thorough cold-water wash; the sample was thoroughly soaped (2g/L) at a boil for 15 minutes; washed once more with water; and then dried in the air. Fig.2 (a) & (b) shows the dyed sample of Novacron reactive dye.

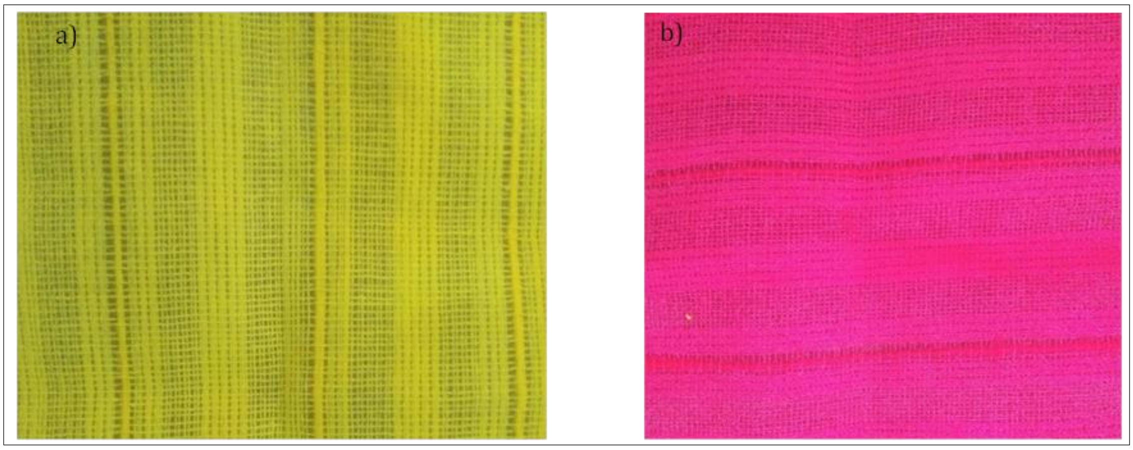


**Figure 2** Reactive dyed blended jute fabric (a) Novacron Yellow (b) Novacron Rose

*2.1.4. GSM*

One square meter of fabric was cut according to a meter square frame and weighted by a top load electronic balance for the determination of GSM. Fig 3 (b) shows the GSM cutter machine.

*2.1.5. Water Uptake*

Jute-cotton blend fabrics were tested for water absorption in a 1000 ml static glass beaker filled with distilled water. The combined fabrics were sized according to preference. (12 X6 X2 cm). The blended fabrics were tested for water absorption for up to 10 days at 25°C room temperature. Samples were removed at predetermined intervals and kept in a room environment for 24 hours. The sample's weight was recorded both before and after the immersion. The following Equation 1 was used to calculate water uptake on a percentage basis.

$$\text{Gain of water} = \frac{Final\ weight - Initial\ weight}{Initial\ weight} \times 100 \ldots\ldots\ldots\ldots (1)$$

*2.1.6. FT-IR Spectroscopy*

The functional group of the produced composite materials was determined using Fourier transform infrared spectroscopy; or FTIR (Fig. 3(a)). The functional group was determined using the FTIR-attenuated total reflectance (ATR) instrument (L1600300 Spectrum TWO LiTa; Serial Number 97505; Made in Llantrisant UK). The machine's wave number ranged from 400 to 4000 cm−1.

**Figure 3** a) FTIR spectroscopy tester b) GSM cutter (James heal)

## 3. Results and discussion

As mentioned in a preceding section; three different treatment procedures were employed for treatment of blended jute fabrics in order to examine the effects of dyed treatment procedures on the resulting. The effects are discussed in the sequel.

### 3.1. Study of GSM

The GSM of the samples for three different grey blended fabrics were measured in 'Before Dyeing' Stage & the change in percentage in respect to 'Required GSM' was shown on the graph below.

Similarly; the GSM of the samples for three reactive dyed fabrics were measured in 'After Dyeing' Stage & the change in percentage in respect to 'Required GSM' was shown on the graph below. It can be observed from the Fig. 4 that dyed blended jute fabric GSM is higher comparing to grey jute blended fabric because the absorbency of dye was in a significant level which raises the weight of the fabric. The grey fabric GSM ranges from 67 to 70; on the other hand dyed sample GSM turned in the regime of 76 to 79.

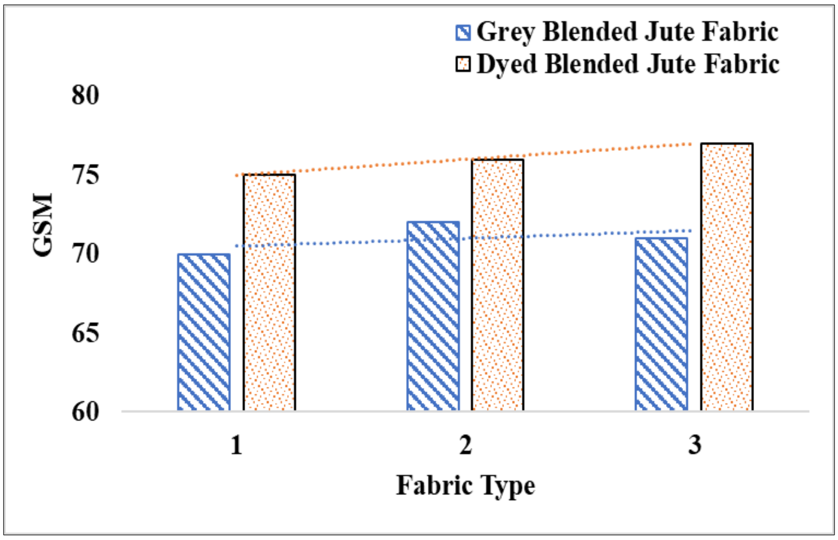


**Figure 4** Comparison of Grey and Dyed Blended jute fabric GSM

### 3.2. Water uptake of blended jute fabrics

The mixed Jute fabric's water absorption was observed during 140 minutes (Fig. 5). With an average value of 140 minutes; the fabric absorbed roughly 145% of the water. Good proof for the hydrophilicity of jute and cotton fiber comes from this water absorption characteristic of the mixed fabric. This nature resulted from the jute and cotton fiber microstructure. Since mostly cellulose molecules make up both of the fibers. Comprising hydroxyl groups in its structure; this cellulose molecule is the polymer of a glucose molecule. Hydroxyl groups draw water molecules in their polarity. From the interaction of hydroxyl group and water molecule; the jute fiber and the cotton fiber turn hydrophilic.

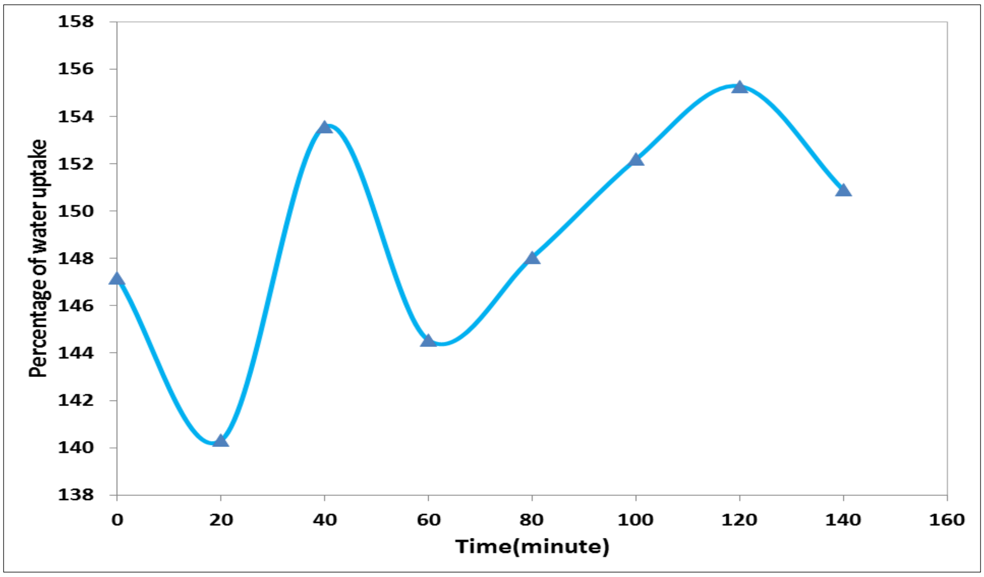


**Figure 5** Water uptake percentage on jute cotton blended fabric

### 3.3. FT-IR analysis

*3.3.1. Grey Blended Fabric FT-IR*

The functional groups in the gray jute-cotton mixed fabrics were identified using FT-IR analysis. A peak for the polymeric -OH group was observed at wave number 3291 cm−1. Like in cotton fiber; hydroxyl groups can be found in the cellulose structure of jute fibers. Another peak was found in the 1735 cm−1 range; it was related to the existence of the $CH_3$; CH; and $CH_2$ group (for sp3 bonding). Another peak for the -CH group (for sp3 vibrational stretching) was seen in the area of 2877 cm−1. A further peak was noted for the C=O functional groups at 1843 cm−1. Fig. 6 displays the results of the FT-IR investigation of blended jute and cotton fabrics.

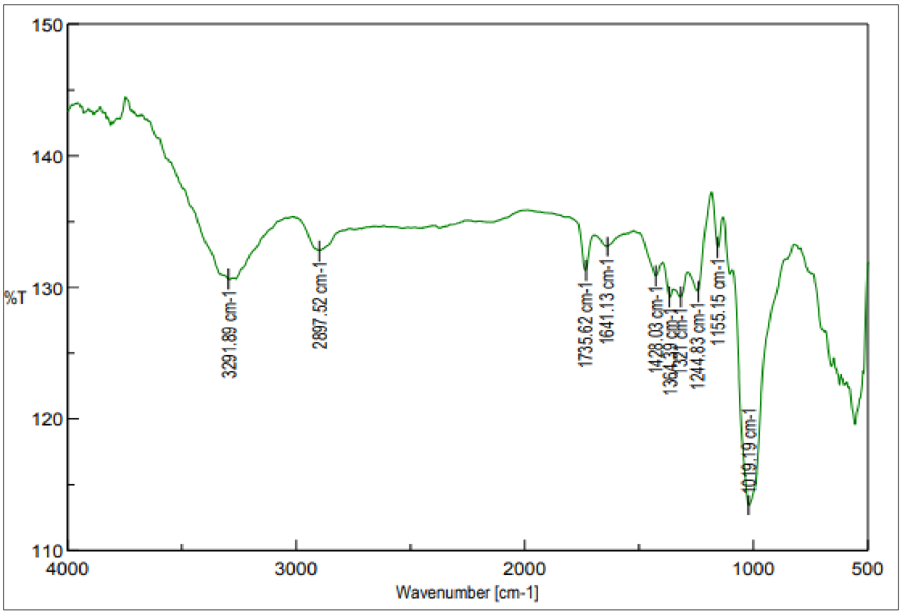


**Figure 6** FT-IR analysis of grey jute-cotton blended fabrics

### 3.4. Reactive dyed FT-IR Analysis (Yellow)

The functional group of the colored blended cloth was ascertained by FT-IR investigation. The FT-IR machine did not find any additional functional groups since no chemical bonding took place during the blended grey cloth processing. Comparatively; both composites showed a similar peak. For both composites; a similar peak was seen in the fingerprint region (400– 1300 cm-1). Figures 7 show the several ranges of dyed mixed fabric peaks in turn. A peak was noted in the 1366 cm−1 region and this peak corresponded to the existence of $CH_3$; CH; and $CH_2$ group (for sp3 bonding). A peak was noted for the C=O bond's functional groups in 1724 and 1726 cm−1. The –CH group peak appeared in the 2919 cm−1 area (for sp3 vibrational stretching). The wave number of 3330 cm−1 showed a peak for the presence of the polymeric –OH group. The blended fabric's presence of colored peaks indicates that chemical alteration resulted in the formation of a molecular link. Thus; it is evident that the jute cotton blended fabric has a notable degree of colored absorbency.

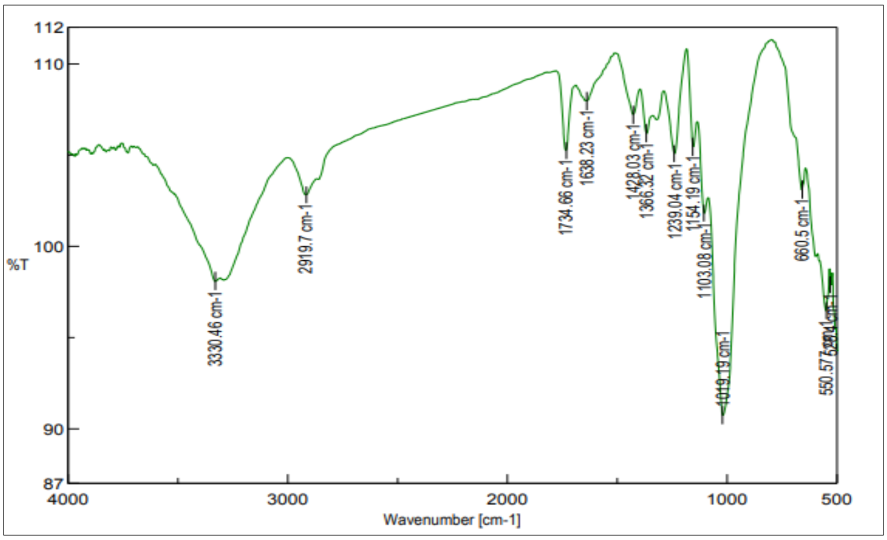


**Figure 7** FT-IR analysis of Dyed jute-cotton blended fabrics (Yellow)

### 3.5. Reactive Dyed FT-IR Analysis (Rose)

FT-IR spectroscopy was used to examine the bleached and best dyed mordanted cotton fibers in order to determine structural changes brought about by the dye and mordant effects. Figures 8 respectively illustrate the bleached and dyed cotton fabric. For the spectrum of the dyed mordanted fabric compared to the bleached fabric; there are two notable alterations producing an increase in peak intensity at 3330.3cm−1 and 2919.7cm−1. The alterations are ascribed to the rise in the number of the functional groups connected to the –OH molecular bond producing its stretching vibration (OH wagging in phenolic compounds).

The –OH group participates in bonding during the dyeing process; consequently; a shift in peaks is expected. Since this functional group does not engage in bonding during dyeing; the position of the $CH_2$ peaks at 2932.89 cm−1 does not clearly shift. Analogously, after their surface changes; -OH twisting in cellulose and banana fibers is found accordingly.

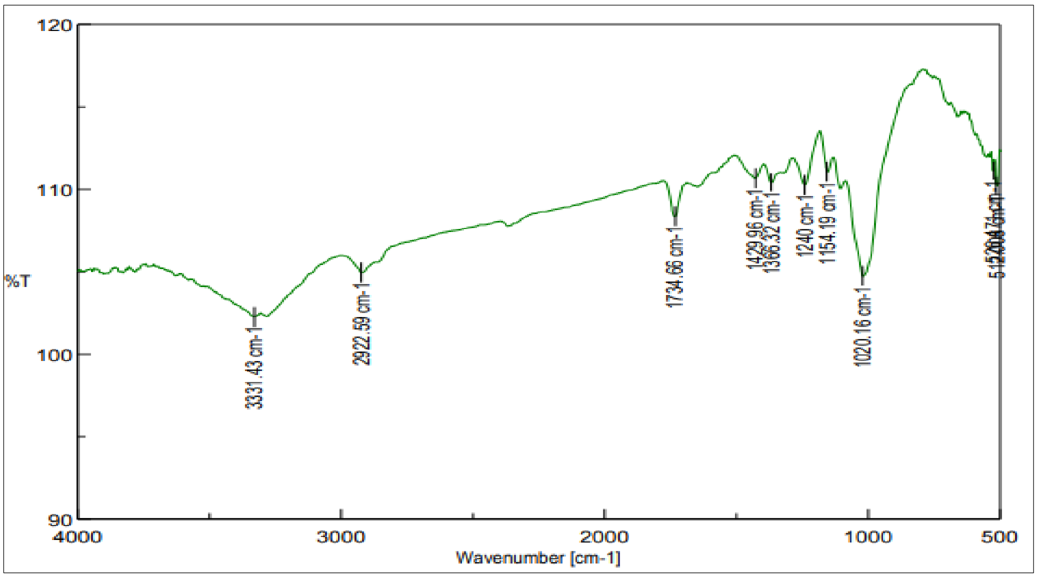


**Figure 8** FTIR of reactive dyed jute cotton blended fabric (rose)

## 4. Conclusion

The goal of this study is to enhance blended jute fabric's ability to absorb reactive dye following bleaching. Applying two separate colors of reactive dye to mixed jute fabric raises the hydroxyl group for fixing and strengthens the cationic sites for dye adsorption. As a result; when comparing the treated fabric to the untreated fabric; dye exhaustion and depth of shade improve. Even if wet rubbing and washing receive a lesser fastness rating; the total fastness grade is still acceptable. For this reason; treating jute with reactive dye may be a useful method for coloring jute fabric.

## Compliance with ethical standards

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*Disclosure of conflict of interest*

No conflict of interest to be disclosed.

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