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**Research Article**

# Extraction of sustainable dye from *Syzygium cumini* for various fibers

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**Abstract**

This study examines the extraction and application of *Syzygium cumini* bark dye on textile fibers using different mordant combinations. Mordants such as $FeSO_4$, oxalic acid, $SnCl_2$, and alum were applied in 1:1 and 2:1 ratios to develop various shades. The dye showed good performance on jute fibers, with dyed samples exhibiting good to excellent color fastness properties.



*Keywords:*
Jute, Dyeing, Sustainable Dye, Jambolan (Jamun) .

## 1. Introduction

Traditionally, people have dyed textiles using locally available natural materials that produce bright and durable colors, such as Jamun bark [1]. Natural dyes were relatively inexpensive, offered a wide range of shades, and improved the overall quality of dyed materials [2]. Natural dyeing practices are as old as textile coloration itself, although historically only a limited proportion of textiles were colored using plant-based dyes. In recent years, growing consumer awareness of the environmental and ecological concerns associated with synthetic dyes has renewed interest in natural dyes [3–6]. *Syzygium cumini* Linn, an evergreen tree belonging to the family Myrtaceae, is one such potential source of natural dye.

The jambolan plant, commonly known as Jamun or black plum (*Syzygium cumini* Linn), is a well-known species belonging to the family Myrtaceae [2]. It is a fast-growing evergreen tree that can reach heights of up to 25m, characterized by a grayish-white young stem and a coarse, darkened lower bark [7–10]. The stem bark is considered one of the most potent parts of the plant due to its high tannin content, particularly gallic acid, which contributes to its astringent properties. The deep purple coloration of the fruit is attributed to the presence of cyanidin diglycosides [11]. Ripe fruits of *Syzygium cumini* are widely used in the preparation of beverages, squashes, jellies, wines, and preservatives [12]. In addition to its dietary applications, the seeds are traditionally used to manage various ailments, notably diabetes mellitus [13]. Different parts of the Jamun plant have been reported to exhibit antioxidant, anti-inflammatory, neuropsychopharmacological, antibacterial, antifungal, anti-ulcerogenic, hypoglycemic, and radioprotective activities, attributed to the presence of tannins, flavonoids, essential oils, and organic acids [14, 15]. An astringent decoction prepared from Jamun bark is also traditionally used for gargling purposes.

The herbal dyeing process involves three major steps [16, 17]. The first step is the extraction of the colorant from plant parts such as stems or bark. This is followed by the formation of a bond between the extracted coloring matter and the textile fiber, a process facilitated by the use of a mordant. The final step is the actual dyeing of the fiber. Mordanting enables effective fixation of the dye on the fiber, leading to the development of new shades with improved color fastness and reproducible color yield. As most natural dyes are non-substantive in nature, they require the use of mordants such as stannous chloride ($SnCl_2$), potash alum, ferrous sulfate ($FeSO_4$), and oxalic acid for effective application on textiles. Linn. can reach heights of 20?25 m with a girth of 2?3 m and may live up to 100 years

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in suitable locations. Its medicinal properties are primarily attributed to compounds such as maleic acid, oxalic acid, gallic acid, and tannins [18–21]. While the entire plant is used in traditional medicine, the leaves and stem bark are considered the most potent parts, with gallic acid in the bark largely responsible for its astringent effects. The purple coloration of the fruit is due to cyanidin diglycosides [22–24]. Various studies have reported that tannins, flavonoids, essential oils, and organic acids in Jamun exhibit diverse pharmacological activities, including gastroprotection, anti-ulcerogenic, antibacterial, anti-infective, anti-inflammatory, hypoglycemic, antioxidant, and radioprotective effects [25–27]. Additionally, an astringent decoction prepared from Jamun bark is traditionally used as a gargle [28]

## 2. Materials and Methods

### *2.1. Preparation of raw materials*

The raw material of Jambolan bark are cut from the trunk of Jambolan tree and they were cleaned with water by brushing to remove the impurities and allowed to soak in warm water for 12 hours then heated and boiled for 1-2 hour. After than slowly heated and boiled for 2-3 hours at 90°C reduce the extraction time silvaaetal L007. One hundred gram of Jambolan bark powder are placed in a round bottom flask with 500 ml of water are added into it. The flask is heated in water bath at 60°C for one hour. The above processes repeated 3 times at 60°C. The extracted dye solution put into the petridish for evaporation of water. After extracting the dye from dye solution is dried in the oven at 60°C. This dyestuff is extracted as powder form after evaporation.

Post mordanting technique are applied for dye the Jute. It is technique which applied after dyeing the fiber a mordant can give color. The dyed material is treated with a mordant which are used the fix a dye with fiber ad give the color. They also improve the take up quality of fiber, color and light fastness.

### *2.2. Chemicals*

Detergent ECE (without optical brightener) sodium per borate, 1-histidine monochloride monohydrate, sodium dihydrogen orthophosphate, distilled water, sodium carbonate, sodium hydroxide, acetic acid, sulphuric acid, and perchloroethylene solvent. All the chemicals and solvents used were of AR grade.

### *2.3. Collection of Bark and Extraction of Color*

Jamun bark was purchased from Murree market and thoroughly washed with water and dried. It was ground into powder and sieved through 22 mesh size strainer. 500 g bark powder was soaked in 5 L water over night, boiled for 2 to 3 h and then subjected to stirring for 3 to 4 h at simmering temperature. A dark brown colored due solution obtained which was filtered and kept for dyeing and other tests.

### *2.4. Color Fastness to washing*

The dyed sample Jute was shaked with detergent solution for 30 minutes report that rinsing procedure once more with a new rinsing float. Dried the sample and extent of fading examined the wash fastness rating was assessed using grey scale. Instruments D400IR dyeing machine (SDL Atlas Englang); Launderometer (Roaches), Perspirometer kit (SDL Atlas England); oven Ci 3000 + Xenon: weatherometer (Atlas England); water bath; grey scales for staining (ISO 105 A03); grey scale for change in shade (ISO A02); crockmeter 9SDL Atlas England); multifiber (DW).

### *2.5. Dyeing with Jamun bark*

Fabric of cotton, Jute and silk 20 g each were dyed with same depth of jamun bark dye, bark dye extract in the D400 IR dyeing machine (SDL Atlas England) at 100°C for 1 h with speed of circulation 1.5 rpm.

### *2.6. Fastness determination*

Wash fastness test of all the three dyed fabrics was determined according to ISO 105 C06 method. Light fastness was examined according to ISO 105 standard method procedure B02. Rubbing fastness (dry and wet) test was carried out according to ISO 105x12 standard test procedure. Color fastness tests to dry cleaning, water, sea water, and perspiration (acidic and basic) were carried out according to ISO 105:D01,E01,E02 and E04 methods, respectively. Color fastness to spotting of acids and alkalies test were performed according to ISO E05 and E06 methods, respectively (BS 1006:1990).

### *2.7. Washing Fastness*

Washing fastness was determined by preparing the soap solution containing 4 g detergent and 1 g sodium perborate per liter of distilled water. pH was adjusted to 10.5+0.1 by addition of approx. 1 g of sodium carbonate. Jute, cotton and silk fabric pieces of size 10x4 cm were attached to multifiber DW of the same measurements by sewing along with one of the shorter sides. Three composite specimens were put into glasses of launderometer (Roaches) for 30 min at 60°C having liquor ratio 50:1.Launderometer or Washtec consists of a water bath containing a rotatable shaft which supports radially, stainless steel container (75+5 mm diameter x 125+10 mm height) of capacity 550+50ml, the bottom of container being 45+10 from the center of shaft. The shaft/container assembly is rotated at a frequency of 40+2/min. After 30 min, samples were removed from the Washtec. Stitches were removed and the specimens were dried at temperature not more than 60°C. The change in stain and shade was assessed with the help of grey scale.

### *2.8. Color Fastness to Perspiration*

Test were carried out by dipping the fabrics into 1-histidine monohydrochloride monohydrate solution according to ISO 105 E04 method. Specimens of Jute, cotton and silk of 4 cm x 10 cm measurement were attached to pieces of multifibre of the same measurement by sewing along with one of shorter sides and dipped separately into alkaline and acidic solutions for 30

min having liquor ratio 50:1. Then the Jute, cotton and silk specimens were placed in the perspirometer kits and the desired pressure was applied. Perspirometer kits are test devices each consisting of a frame of stainless steel into which a weight piece of ass 5 kg and base of 60 mm x115 mm is closely fitted so that a pressure of 12.5 kpa can be applied on test specimens measuring 40 mm x 100 mm, placed between glass or acrylic resin plates measuring 60 mm x 115 mm x 1.5mm. The test device is constructed in such a way that a pressure of 12.5 kpa remains unchanged. The perspirometer kits (acidic and basic) for tests of the three fabrics were placed in the vacuum oven for 4 h and then the kits were removed from the oven and the stitches were opened except on one shorter side. Specimens were dried at 60°C by hanging in air. Change in color of each specimen and staining of the adjacent fabric (DW) were assessed with grey scale.

### *2.9. Rubbing Fastness*

Dry rubbing on Jute was carried out with the help of crockmeter under a pressure of 9 N in to and fro movements on standard rubbing cloth. The sample cotton of 5 cm x 14 cm measurement was taken. Both warp and weft readings were noted. Same procedure was adopted for jute and silk and values were taken with the help of grey scale.

### *2.10. Wet rubbing*

Wet rubbing on Jute fabric was done under the same conditions of crockmeter as in the dry rubbing except the standard rubbing soaked into 100% deionized water. Same procedure was repeated with cotton and silk fabrics and the change in color and in stain was assessed with the help of grey scale.

### *2.11. Light Fastness*

Light fastness was carried out according to ISO 105 standard procedure B02; in weatherometer by Atlas. Xenon arc lamp was used which is an artificial light source representative of natural day light D65. Fabrics of measurement 7 cm x 12 cm of cotton Jute and silk were exposed to Jamun bark dye and color fastness. Xenon arc lamp for 24 h, at standard testing conditions using blue wool as standard reference fabric. The above three treated fabrics were compared with grey scale for evaluation.

### *2.12. Color Fastness to Dry Cleaning*

Undyed Jute twill bags of 10cm x 10 cm measurement were stitched around three sides and Jute. Jute silk pieces of 4 cm x 10 cm measurement were placed into separate bags along with 12 non-corrodable steel disks and the fourth side of the bag was sewed. Then the bags were placed in separate containers of Washtec containing 200 ml of perchloroethylene solvent and agitated for 30 min at 30+2°C. Afterwards the bags were removed from the container. The samples were squeeze to remove surplus solvent and dried in the air by hanging them at a temperature of 60+5 °C. Assessment of change in color of samples and change in color of solvent was carried out with the help of grey scale.

### *2.13. Color Fastness to Water*

Color fastness to water was evaluated in the same manner as for the color fastness to perspiration. ISO-105 E01 and E02 methods was used for water and sea water, repectively. In case of water, fabrics were dipped in deionized water, while for color fastness to sea water, fabrics along with multifibers were dipped in NaCl solution (30 g/l) for 30 min.

For both water and sea water the above three treated composite fabrics were put in perspirometer kit. These kits were placed in the oven for 4 h at 37+°C. Then the specimens were dried at temperature not more than the specimens were dried at temperature not more than 60°C. Change in shade and in stain were noted with the help of grey scale.

### *2.14. Color Fastness to Dry Heat*

Dry hot pressing was done according to ISO 105 XII. Specimens of Jute, cotton and silk were pressed at temp. 110+2 °C with hand iron and change in color was assessed with grey scale .

### *2.15. Color Fastness to Spotting Acids and Alkali*

Scope of acetic acid 300 g/l, sulphuric acid 50 g/l, tartaric acid 100 g/l and $Na_2CO_3$, 100 g/l of water were put on the specimens and change in shade was assessed with ISO-105 A02 grey scale.

## 3. Results and Discussion

### *3.1. Antioxidant Activity of Sweet Lime Peel*

The dyed textile was immersing in separate vessel in the artificial perspiration solution placed the specimen between two glass plates in the apparatus and loaded it with a weight of 4.5 Kg, placed it in the oven at 37+2°C for three hours at 37+2°C for houses in color of scale (AAtCC-1995). At the end of this period sample was removed and the test piece was separate from the two pieces of the untreated fabric and dried in air at a temperature not exceeding 60°C.

The dyed sample of wet/dry Jute fabric were placed over the end of finger of testing device and rubbed. Over to end of the finger of the testing device and rubbed it to and form in a straight line. The pieces were dried at room temperature. The degree of fabric was evaluated with to help of grey scale and the numerical rating were assigned.

### *3.2. Change in staining*

When the washing fastness characteristics of cotton, jute cotton, and silk were tested, it was found that the staining performance of jute and silk textiles was excellent (5) on a diacetate band of multi-fiber DW for jute fabric. Staining was good for jute fabrics (4-5) rating and (4) for cotton fabric for multifiber cotton band. Cotton fabric produced outcomes for the nylon band of multi-fiber that were satisfactory (3-4) and good (4-5) for jute and silk. All fabrics for polyester band received the same grade of 4. All three fabrics for the polyacrylic and cotton band received an outstanding (5) stain grade (Table 1).

Table 1: Fastness grades of Jute dyed with Jambolan colorant with at optimum dyeing condition using $SnCl_2$ : Oxalic acid

| Mordanting | Mordanting portion or ratio combination | Light Fastness | Wash Fastness | | | Rub Fastness | | | | Fastness Perspiration | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | Dry | | | Wet | | | |
| | | | CC | CS | CJ | CC | CS | CJ | CC | CS | CC | CJ |
| Post mordanting by $SnCl_2$ + oxalic acid | 1:1 | 4 - 4.5 | 5 | 5 | 5 | 5 | 5 | 5 | 4.5 | 5 | 5 | 5 |
| | 1:2 | 4 - 4.5 | 4 | 5 | 5 | 5 | 5 | 5 | 4.5 | 5 | 5 | 5 |
| | 1:3 | 4 - 4.5 | 4.5 | 5 | 5 | 5 | 5 | 5 | 4.5 | 5 | 5 | 5 |

C = Cotton, S = Silk, J = Jute

Table 2: Fastness grades of Jute dyed with Jambolan Colorant at optimum dyeing condition using $SnCl_2$ : Ferrous sulfate

| Mordanting | Mordanting portion | Light Fastness | Wash Fastness | | | Rub Fastness | | | | Fastness Perspiration | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | Dry | | | Wet | | | |
| | | | CC | CS | CJ | CC | CS | CJ | CC | CS | CC | CJ |
| Post mordanting by $SnCl_2$ + $FeSO_4$ | 1:1 | 4 - 4.5 | 5 | 5 | 5 | 5 | 5 | 5 | 4.5 | 5 | 5 | 5 |
| | 1:2 | 4 - 4.5 | 4 | 5 | 5 | 5 | 5 | 5 | 4.5 | 5 | 5 | 5 |
| | 1:3 | 4 - 4.5 | 4.5 | 5 | 5 | 5 | 5 | 5 | 4.5 | 5 | 5 | 5 |

C = Cotton, S = Silk, J = Jute

Table 3: Fastness grades of Jute dyed with Jambolan Colorant at optimum dyeing condition using $SnCl_2$ : Potash Alum

| Mordanting | Mordanting portion | Light Fastness | Wash Fastness | | | Rub Fastness | | | | Fastness Perspiration | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | Dry | | | Wet | | | |
| | | | CC | CS | CJ | CC | CS | CJ | CC | CS | CC | CJ |
| Post mordanting by $SnCl_2$ + Potash | 1:1 | 4.5 | 5 | 5 | 5 | 5 | 5 | 5 | 4.5 | 5 | 5 | 5 |
| | 1:2 | 4.5 | 4 | 5 | 5 | 5 | 5 | 5 | 4.5 | 5 | 5 | 5 |
| | 1:3 | 4.5 | 4.5 | 5 | 5 | 5 | 5 | 5 | 4.5 | 5 | 5 | 5 |

C = Cotton, S = Silk, J = Jute

Table 4: Rubbing fastness, light fastness and color fastness to dry cleaning

| Fabric | Rubbing fastness | | Light fastness | | color fastness to dry cleaning | | |
|---|---|---|---|---|---|---|---|
| | Dry wrap | Rubbing wet | Wet wrap | Rubbing wet | Change in shade of fabric | Change in shade of fabric | Change in shade of solvent |
| Jute | 4 - 5 | 4 - 5 | 3 - 4 | 4 | 4 | 5 | 5 |
| Cotton | 4 - 5 | 4 - 5 | 3 - 4 | 3 - 4 | 4 - 5 | 5 | 5 |
| Silk | 5 | 5 | 4 - 5 | 4 - 5 | 4 | 5 | 5 |

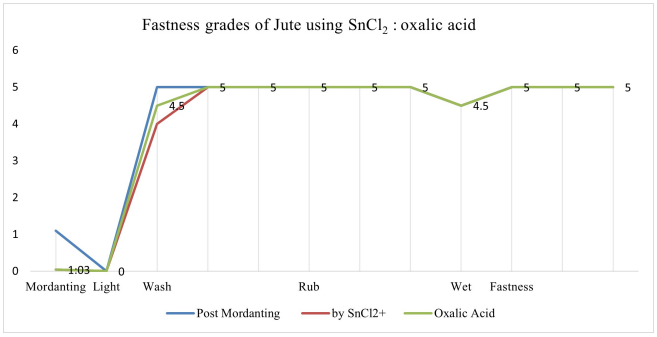


Figure 1: Fastness grades of Jute using $SnCl_2$ : oxalic acid

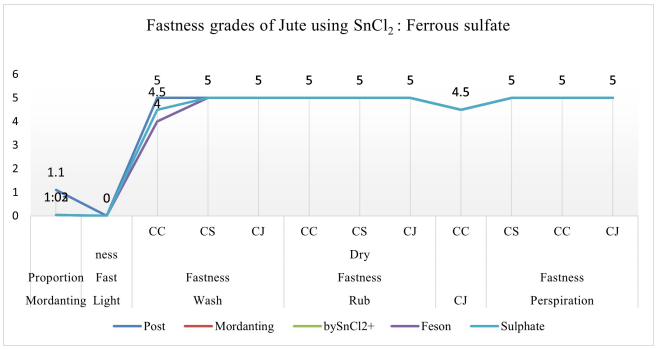


Figure 2: Fastness grades of jute using $SnCl_2$ : Ferrous sulfate

### 3.3. *Change in shade*

Jute received a satisfactory (3-4) assessment for the results of change in color. Jute receives a grade of 4, while silk has a bad (2-3) rating compared to the other two textiles. Table 1 shows the results for shade changes for jute, cotton, and silk dyed with walnut bark extract.

#### 3.3.1. *Jute fabric*

The results of acidic and basic sweat on a jute cloth on diacetate band were favorable (4-5). Acidic and basic sweat on a jute and nylon band produced staining results of 4. Both basic and acidic sweat produced great results (5) for the polyester band. Excellent (5) for acidic perspiration and good (4-5) for basic perspiration were discovered for polyacrylic band. Results for both perspirations for wool band were favorable (4-5). For acidic sweat, the change in shade was 4, however for basic perspiration on jute cloth, it was good (4-5). Excellent (5) rating was given for the multifiber diacetate band by acidic and basic sweat. For Jute bands, the stain change for both acidic and basic sweat was favorable (4-5). The staining for the nylon band was the same, or (4). Both sweat and polyester and polyacrylic band staining were excellent (5). Wool band also produced good (4-5) and excellent (5) staining for basic and acidic sweat, as well as good (4-5) and outstanding (5) shade changes for both types of perspiration.

#### 3.3.2. *Silk fabric*

The diacetate band demonstrated outstanding (5) rating for basic perspiration and good (4-5) rating for acidic perspiration for silk fabric treated with walnut dye. For multifiber Jute bands, the stain change was good (4-5) for basic sweat and outstanding (5) for acidic sweat. For both acidic and basic sweat, polyester band staining received an excellent (5) rating. Excellent (5) for basic perspiration and good (4-5) for acidic perspiration for silk fabric were the results for polyacrylic band. Basic and acidic perspiration from nylon bands produced satisfactory (4-5) results on silk. Silk fabric received a favorable (4-5) assessment from the wool band for both acidic and basic sweating. The rating for basic perspiration was outstanding (five), while the rating for acidic perspiration was good (four to five).

### 3.4. *Light fastness*

Results of the light fastness test for jute, wool, and silk dyed with extract of walnut bark are displayed in Table 2. While cotton received a decent grade (4-5), jute and silk received a rating of 4. Dry cleaning. Results of color change for jute, cotton, and silk materials were outstanding (5). Excellent solvent color change was also seen (5) for all three textiles.

### 3.5. *Rubbing fastness*

#### 3.5.1. *Dry rubbing fastness*

While silk fabric displayed outstanding rating (5) for dry rubbing fastness along warp and weft, jute and cotton both provided good ratings (4-5) for this property.

#### 3.5.2. *Wet Rubbing fastness*

Wet rubbing along the warp for jute fabric was 3-4, which was satisfactory and acceptable. There were four weft wet rubbings. Wet rubbing fastness along warp and weft for woolen fabrics was 3-4, which is also acceptable. Silk fabric received a good (4-5) wet rubbing fastness grade along the warp and weft. The outcome is displayed in Table 2.

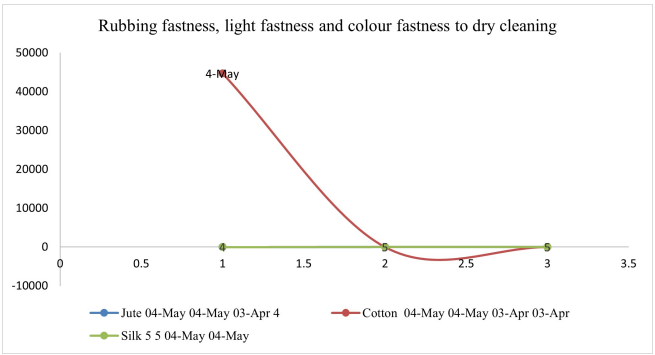


Figure 3: Rubbing fastness, light fastness and color fastness to dry cleaning

### 3.6. *color fastness to water*

#### 3.6.1. *Change in stain*

Diacetate band received a good (4-5) grade for jute fabric. The assessment of stain change for fabrics made of wool and silk was outstanding (5). All three fabrics for the multifiber DW's jute band displayed the same grade, a respectable

4-5. For staining on nylon band, jute and silk had ratings of 4, whereas wool received ratings of (4-5). Results for the polyester band were excellent (5) across all three fabrics. Jute and silk received a reasonable grade (4-5) on the polyacrylic band, whereas wool received an exceptional rating (5). For Jute staining, the wool band of multifiber gave a rating of 4, 4-5 for Jute, and a rating of 5 for silk fabric (Table 3).

### *3.6.2. Change in shade*

For all three materials, the rating for color fastness to water change was good (4-5). In Table 3, results are displayed.

### *3.7. Color fastness to sea water*

Table 3 includes the results of color fastness to sea water. Staining. Jute fabric demonstrated a staining grade of 4, wool demonstrated an exceptional rating of 5, and silk had a decent (4-5) rating. Excellent (5) grade for the staining of jute, wool, and silk with walnut bark dye was given to the multifiber jute band. Wool and silk received fair (4-5) results from nylon band, whereas jute fabric received an exceptional (5) rating. For Jute fabric, the polyester band gave a good staining grade (4-5) and an exceptional rating (5) for both wool and silk. Jute, wool, and silk received stain ratings of 5, 4-5, and 4 from the wool band of multifiber (DW) (Table 3).

### *3.8. Color fastening speed to water*

Change the color of. Diacetate band received a fantastic (4-5) grade for jute texture. The modify in recolor rating for woolen and silk texture was amazing (5). All three textures for the multifiber DW's jute band looked to be rated the same, at 4-5, which was excellent. Jute and silk provided ratings of 4 for recoloring in nylon band, whereas woolen provided ratings of (4-5). For all three textures, polyester band developments were excellent (5). Excellent grade (4-5) for Jute and Silk and fantastic rating (5) for Fleece were given to the polyacrylic band. For Jute's ability to change color, the fleece band of multifiber awarded it a rating of 4, 4-5, and 5 (Table 3). Alter in shade For all three textures, the rating for how quickly colors changed in the presence of water was excellent (4-5). The results are shown in Table 3.

### *3.9. Color quickness to ocean water*

Table 3 also includes result of color reactivity to ocean water.

### *3.10. Recoloring*

Jute texture looked to be rated at 4, fleece at rated at 5, and silk at rated at 4-5 for recoloring on the diacetate band. Jute band of multi-fiber looked fantastic, earning a grade of five (5). The nylon band gave fleece, silk, and jute a great (4-5) and great (5) rating, respectively. fantastic rating (5) for both fleece advertisement silk and fantastic (4-5) rating for Jute texture were given by the polyester band, along with great rating (4-5) for Jute recoloring. Jute, fleece, and silk, individually, received 5, 4-5, and 4 recolor ratings from the fleece band of multifiber (DW) (Table 3).

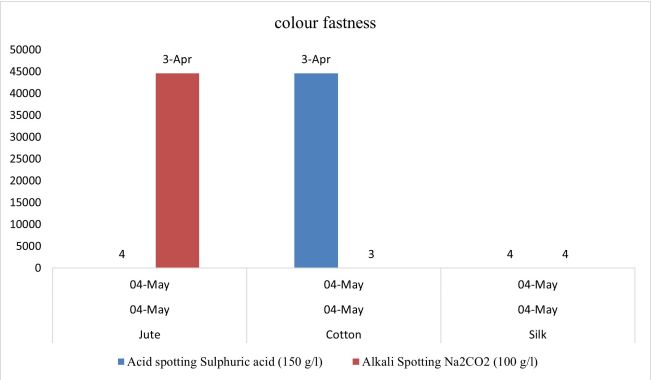


Figure 4: Results of color fastness

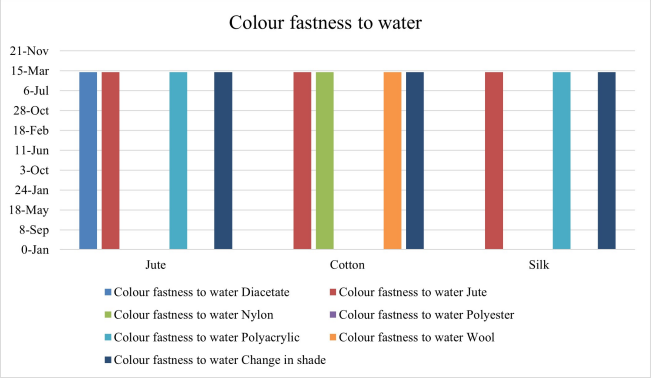


Figure 5: Color fastness to water

### *3.11. Change in shade for sea water*

For all three of the materials treated using jamun bark dye, the color change was satisfactory (4-5).

### *3.12. Dry heat fastness*

Jute and silk textiles performed well (4-5) during dry heat pressing at 110°C. In Table 3, results are displayed.

### *3.13. Color fastness to acidic and basic spotting*

Jute's shade changes. Jute and silk fabrics received a satisfactory rating (4-5) after being spotted with acetic acid (300 g/l). For Jute and silk, Sulphuric acid (150 g/l) spotting yielded a rating of 4, while wool had an acceptable (3-4) rating. Alkali spotting (100 g/l $Na_2CO_3$) gave Jute and cotton fabrics an acceptable rating (3-4) while giving silk fabrics a rating of 4. The outcomes are listed in Table 3.

## 4. Conclusion

The study reveals that *Syzygium cumini* bark dye exhibits excellent to good color fastness properties. Its colors develop quickly and remain long-lasting. The dye can be applied to jute, cotton, and silk fibers without the use of a mordant and achieves satisfactory saturation. It is environmentally friendly and poses no health hazards.

Table 5: Walnut bark dye: Dry heat fastness, sporting to acids and alkalis and color fastness to water

| Fabric | Dry heat fastness at 110 C | Acid spotting | | Alkali spotting | Color fastness to water | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Acetic acid (300 g/L) | Sulphuric acid (150 g/L) | Sodium carbonate (100 g/L) | Diacetate | Nylon | Polyester | Polyacrylic | Wool | Change in shade |
| Jute | 4 - 5 | 4 - 5 | 4 | 3 - 4 | 4 - 5 | 4 | 5 | 4 - 5 | 4 | 4 - 5 |
| Cotton | 4 - 5 | 4 - 5 | 3 - 4 | 3 | 5 | 4 - 5 | 5 | 5 | 4 - 5 | 4 - 5 |
| Silk | 4 - 5 | 4 - 5 | 4 | 4 | 5 | 4 | 5 | 4 - 5 | 5 | 4 - 5 |

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