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An Overview on the Eco-friendly Printing of Jute Fabrics Using Natural Dyes

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JUTE is one of the available and cheap cellulosic fibers that can be printed and used instead of other materials that may be relatively high in price. Jute is one of the bio-degradable raw materials and therefore does not cause harm to the environment along with other advantages and because of its many advantages, it is called golden fiber. Textile printing is the practice of applying color to fibers in distinct patterns or designs with sharp outlines. Inappropriately printed fibers, the color is tied to the fiber, to defend against washing and crocking. Jute fabrics can be printed with all dyes suitable for dyeing jute such as viz.- direct, basic, acid, pre-metalized, vat, azoic (naphthol), reactive, and sulfur dye and natural dyes. However, jute textiles are generally printed with direct-styled pigment colors, using the kerosene or White Spiritor mineral turpentine oil (MTO)-based emulsion thickener and a Fixer-CCL (melamine-formaldehyde resin) to improve rubbing fastness.

Keywords: Jute; Printing; Natural dye; Eco friendly.

Introduction

Jute is a lignocellulosic, multicellular bast fiber, commonly referenced as "Golden Fibres" and farmed predominantly throughout India, Bangladesh, and its subcontinent.[1, 2]

Jute is the popular term for fiber from plants belonging to the Corchorus botanical genus. There are around 40 species spread over the tropics under the genus Corchorus (Family: Tiliaceae). Of all the Corchorus species, man has picked C. capsularis Linn and C. olitorius Linn, both economic and business-related. C. capsularis also known as 'White 'jute and C. olitorius known as 'Tossa' jute include other species found untamed.[3, 4] The largest producers of crude jute fiber are India, Bangladesh, China, Nepal, Myanmar, and Thailand; these countries have favorable agro-climate and socio-economic circumstances suited for the production of jute. The world output of jute is more than 50% in India alone.[5]

Jute is a viscoelastic bast fiber. Cellulose (58 to 63%), hemicellulose (21 to 14%), lignin (12% -14%), Wax (0.4-0.8%), pectin (0.2 to 0.5%), protein (0.8-1.5%), mineral substances (0.6 to.2%) and coloring substance traces are jute.[6, 7] Parallel with overlapping, the fiber bundles are assembled to create filaments throughout the stalk. Jute fibers comprise cells or ultimate fibers that are combined with natural cementing ingredients such as lignin, hemicellulose, etc. Each final fiber consists of a vast amount of smaller fibrils, which are organized in right-hand spirals. Again, the fibrils consist of molecular chains that are kept in tight cooperation. These are called micelles. Although the middle lamella is plentiful in lignin and other noncellulosic components, they are also found in other regions of the cell wall.[8]

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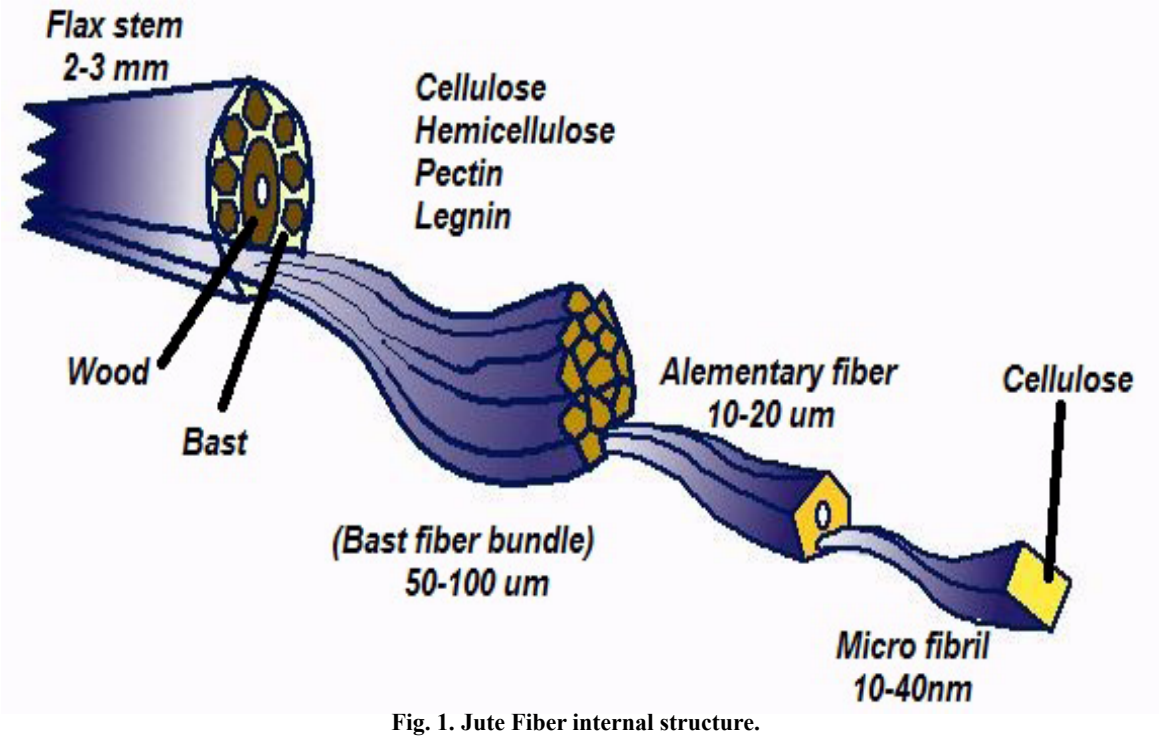

Fig. 1. Jute Fiber internal structure.

Due to its biologically degradable and eco-friendly nature, Jute acquired enormous appeal across the world. Jute has the qualities of a silky luster with high strength and minimal extensibility, apart from being eco-friendly.[9] In addition to its technical benefits, such as strong tensile strength, initial module, recover humidity, good properties of sound and heat insulation, dimensional stability, and good adaptability to the coloration are also available at a reasonable price.[10] It has also some disadvantages, such as partiality, fragility, hardness in feeling, large variation in fiber length and fineness with which it branches, poor washability, and proneness to yellow under sunshine exposure. Occasionally the low extensibility of jute is beneficial and sometimes negative too.[11] Jute, other than its conventional usage as packing material, is used in several diverse and valuable added goods. The area of application includes a hanging wall, a wall covering, curtains and clothing, etc., where the look and feel are pleasant. You may achieve an attractive look either by dyeing or printing.[12]

Textile printing is the practice of applying color to fibers in distinct patterns or designs with sharp outlines. Inappropriately printed fibers, the color is tied to the fiber, to defend against washing and crocking. The selection of dyestuffs used depends on several factors including fiber chemical structure, to achieve fibers with acceptable colorfastness properties. Textile printing is the creation of color models or drawing on textile fabrics. But for the color being applied to limited sections according to a specific design, printing is nearly similar to dyeing operation. However, modern advances in the area of printing, particularly in machinery, thickening agents, and manner of fixation have made printing a significant process in textiles coloration. In addition, due to improved aesthetic appeal, the printed garments are in great demand.[13-15]

The printing is carried out combined with additional auxiliaries by including the dyestuff in a thickening paste. The substratum is printed using rollers or screens that have already been designed. The press paste comes viscous by combining one or more polymers, known as the Thickener, which functions as the vehicle for dyestuffs and auxiliaries, to prevent the color from expanding out of the design part of the fabric and offer a precise outline design. Print Paste, which requires a thickening agent of certain apparent viscosity, is termed the entire composite containing dyestuff, thickener, and other auxiliaries.

Synthetic thickeners are generally high molecular polymeric substances that may generate a high viscosity at very low concentrations[16-18]

Pigment printing

Jute fabrics can be printed with all dyes suitable for dyeing jute such as viz.- direct, basic, acid, pre-metalized, vat, azoic (naphthol), reactive, and sulfur dye and natural dyes. However, jute textiles are generally printed with direct-styled pigment colors, using the kerosene or White Spiritor mineral turpentine oil (MTO)-based emulsion thickener and a Fixer-CCL (melamine-formaldehyde resin) to improve rubbing fastness.

Pigments may be organic or inorganic, most of which are water-insoluble and have no associations with textiles. A polymeric binder film, attached to the fabric surface, either by cross-linking the binder or by external cross-linking between the binder and the fiber, is attaching or holding the paint color on the fiber surface. **[19, 20]**

The binder unit plays a significant part in the pigment printing, which in certain circumstances binds the pigment color by connecting itself or externally to fibers. Binder also influences the brightness of prints and their color rapidity.

The binder is connected to an acidic catalyst such as diammonium phosphate (DAP) during the curing process (either independently or externally). DAP releases phosphoric acid at the temperature of the curing, which releases acid or proton at the appropriate pH for a crosslinking process.

Kerosene oil is used as a thickener in water emulsion, which allows a transparent film to evaporate the necessary viscosity of the print pulp for further drying. Urea is also utilized for hygroscopic purposes. The smell of kerosene or MTO is bad and creates air pollution. Formaldehyde-containing resins are not environmentally sound as its formaldehyde releasable component is a fixer/enhancer in pigment printing.[6] This meant that natural materials had to be used to print jute textiles.

Using Natural dyes in printing

Natural dyes have been widely used in textile dyeng and printingfor their biological activity. **[21-28]**

Using Terminalia Chebula extract

Jute fabric was printed with the printing paste contains: dye 20 g/L (Terminalia chebula (CI Natural brown 6) fruit powder), mordant 2 g/L (copper sulfate ($CuSO_4$), ferrous sulfate ($FeSO_4$) or stannous chloride ($SnCl_2$), thickener 60 g/L (Gum Arabica) and complete to 100 g with hot water) the bleached jute fabric was printed and the printed process was performed with wooden blocks. The samples were steamed in steamer at 102°C and a pressure of 25 Ibs for 15 min for the development of the colors of the printed and ground portions. The samples were then rinsed with cold water, soaped at a temperature of 60°C for 15 minutes with a non-ionic detergent, washed again with tap water, dried, and ironed in a somewhat damp condition.

The results are the best in terms of printed depth. When copper sulfate was used to print Terminalia Chebula color paste, the experiment provided dark brown prints on a white backdrop. When combined with dye, ferrous sulfate was created on the jute cloth by a shade of black hue. In the case of stannous chloride, a cream color print was observed (see **Figure 2**). [29, 30] the highest color yield values were obtained in iron sulfate mordanted fabrics. The prints range from good to very good fastness properties

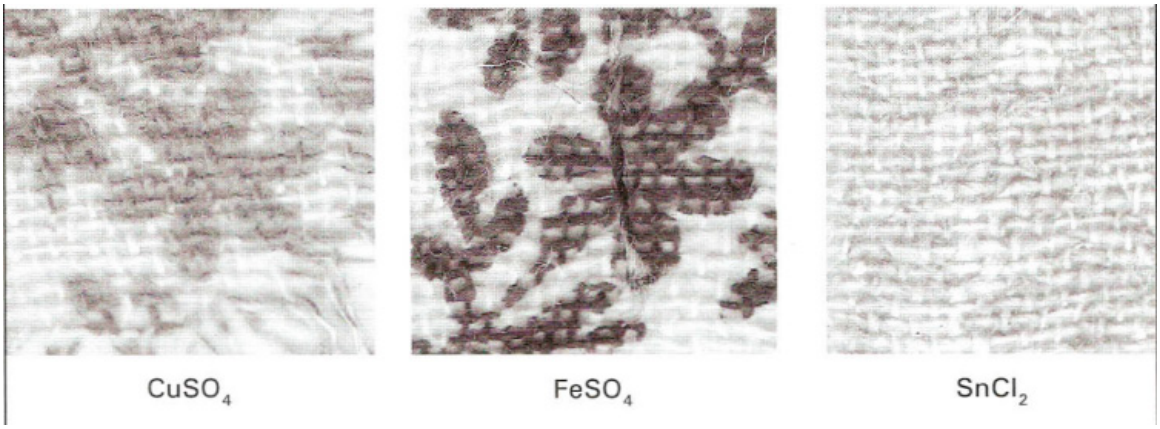

Fig.2. Printed jute fabric in presence of different mordant.

Eco-friendly printing by natural materials

Raw gray fabric is processed by a technique of bio-scouring by treating it with a cellulase enzyme and non-ionic surface-active substance mixed with the xylanase enzyme, at 50°C for 2 h and the pH of 7-9 with 1:10 and the pH of 7-9 of the material-to-liquor ratio. The bath's temperature was raised to 90°C after this treatment, and kept for 15 minutes as a result. The fabric was properly washed in cold water and dried after treatment.

Bleach bio-scoured jute fabric in a closed vessel for 90 minutes at 80-85° C, using a 1:20 liquor ratio with hydrogen peroxide (2 vol.), Ultravon JU (2 ml/L), and sodium silicate (10 g/L). The bath's pH was maintained at 10. The textiles were completely washed in cold water, neutralized with acetic acid (2 ml/L) after bleaching, rinsed again in cold water, and then dried.

Extraction of Myrobolan (Terminila chebula) as Mordant: myrobolan powder (20%, owm) was soaked in water at a liquor ratio of 1.10 overnight for 12 h at 30°C to get swelling myrobolan gel. This gel was then mixed and heated at 80°C for 30 min with a known volume of water. The solution was cooled and filtered into a 60-mass nylon fabric and the filtrate was used as a final mordant solution for mordanting using material-to-liquor ratio at 1:20.

Three different types of natural dyes namely manjistha from roots, ratanjot from the bark of roots, and annatto from seed. Was extracted and used. These dyes were extracted as follows: Dry, powdery from respective parts of different plants like manjistha, annatto, and ratanjot was soaked in water for 12 hours under varied pH conditions (alkaline for annatto & ratanjot and neutral for manjistha). The dye solution was boiled for an hour after soaking. The extracts were cooled down to 30°C and filtered after extraction to remove the insoluble residues. Then, the evaporative drying procedure dried the solutions in the hot sand bath and dry powder was produced.

Jute fabric was carried out using the flat screen technique using printing past contain Guar Gum solution (10 %) as a thickener was boiled for 15-20 minutes, then maintained in natural conditions at room temperature. Then natural dye powder (4 %) and urea (4 %) were added to the thickener paste and stirred well. The samples were dried and steamed for 30 minutes at 100°C. Then samples have been washed for 20 minutes with cold water. After the print fabrics have been steamed, soap with non-ionic detergent (2 g/l) at 40°C for 10 minutes. The printed fabric was cleaned and dried in the air with cold water.

It is observed that in the case of mordant fabric, the color range of the printed samples improves appreciably in terms of K/S value. This can be attributed to the interaction of natural dyes with mordants, which increases color resistance and the fixing of color on the fabric. The fastness of both wash and rub is best discovered when using potash alum as a mordant of myrobolan in the case of mordanted jute fabric and even more. Wet and dry rub fastness is excellent in the case of printed jute fabric using manjistha while it is good in the case of annatto. [12, 31] Finally, for printing attractive, decorative, and fancy designs in jute fabrics, the hairs on the surface of jute fabric are to be removed well, the fabric is to be closely woven with uniform and finer yarns.[6]

Using Vegetable Colour in Printing

Camellia sinensis (tea leaf), Tagetes erecta (Marigold), Rubia tinctorum (Manjistha), Cedrela toona (Indian Mahogany), Terminalia chebula (Harda), and Acacia catechu (Khair) were used as vegetable colorants for jute printing.

Extraction of vegetable colorants: During 12-16 hours, vegetables were dried and then crushed before extraction, in the absence of direct sunlight. The materials that had been dried and crushed were then used for aqueous extraction. By adding 100 g of each herbal material to one liter of water, aqueous extraction was made. The mixture was removed, boiled, and maintained for 45 minutes at the boiling point, let to stand for 15 minutes, and filtered through a nylon bolting cloth. The evaporated water has been replenished with fresh water, allowing for a maximum of 2 liters of dye liquid to be kept.

Scoured and bleached Jute fabric was printed using printing paste contain Aluminium sulfate and ferrous sulfate as mordant, Vegetable colorant as a dye, Gum indulka as a thickener. The imprints were produced with wooden blocks of different patterns. The textiles have been dried after printing at room temperature, followed by steaming in a cottage steamer for 10 minutes at 100°C temperature. After steaming, the printed textiles were rinsed for ten minutes at 50°C immediately with 2 g/L non-ionic detergents to remove the gum and mineral acid created during the steaming process. The printed textiles were

washed with cold water after soaping and were lastly dried in the air.

A well-known dry rubbing fastness property shows that after printing the mere deposition of colors on the jute surface is poor. The color resistance of washing in the presence of inorganic salts is good, because insoluble coloring components present in vegetable colorants, iron, and aluminum form and deposition in the substrate are formed and deposited and thus also improve the light resistance properties of the printed substrates. The fastness values of the textiles exhibited values of all vegetable colors in the range 4.[2, 9]

Conclusion

Jute is an important cellulosic fiber that can be dyed and printed with many types of dyes. The printing of jute fabrics has achieved a tremendous result in printing using natural dyes in terms of fastness to rubbing, light, and washing, in addition to being eco-friendly and harmless.

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نظرة عامة على الطباعة الصديقة للبيئة لأقمشة الجوت باستخدام الأصباغ الطبيعية

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الجوت هو أحد الألياف السليلوزية المتوفرة والرخيصة التي يمكن طباعتها واستخدامها بدلاً من المواد الأخرى التي قد يكون سعرها مرتفعًا نسبيًا. الجوت هو أحد المواد الخام القابلة للتحلل الحيوي وبالتالي لا يسبب ضررًا للبيئة إلى جانب المزايا الأخرى ، وبسبب مزاياه العديدة يطلق عليه اسم الألياف الذهبية. طباعة المنسوجات هي ممارسة تطبيق الألوان على الألياف ذات الأنماط أو التصاميم المميزة ذات الخطوط العريضة الحادة. الألياف المطبوعة بشكل غير لائق ، يتم ربط اللون بالألياف ، للحماية من الغسل والاحتكاك. يمكن طباعة أقمشة الجوت بجميع الأصباغ المناسبة لصبغ الجوت مثل الأصباغ المباشرة ، الأساسية ، الحمضية ، المعدنية مسبقًا ، الضخامة ، الآزويك (النفثول) ، الصبغة التفاعلية والكبريتية والأصباغ الطبيعية. ومع ذلك ، تُطبع منسوجات الجوت عمومًا بألوان صبغية مباشرة ، وذلك باستخدام الكيروسين أو زيت التربنتين المعدني الأبيض ***(MTO Spiritor)*** القائم على مستحلب مثخن و ***Fixer-CCL*** **(راتنجات الميلامين فورمالدهايد) لتحسين ثبات الاحتكاك.**

الكلمات المفتاحية: الجوت؛ طباعة ؛ صبغة طبيعية صديقة للبيئة