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Recent Advances in Jute Coloration

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Abstract

The article comprehensively reviews some significant attempts in the dyeing of jute fibre. Jute fabric has been printed with natural dyes extracted from manjistha, annatto and ratajot. Prior to this the grey jute fabric has been treated with cellulose/zylanase enzyme combination in presence of non ionic detergent and mild alkali, bleached by eco-friendly oxidising bleaching agent, double mordanted. Investigation has been done regarding compatibility of binary mixture of direct dyes by conventional method as well as a new simplified and easier method for application of direct dyes combination on jute, and the findings of both the methods have been compared.

Keywords: Jute fabric; Natural dyes; Printing; Direct dye; Colorimetric method; Dyeing

Introduction

The antiquity of natural dyes and dyeing can be traced back to the Bronze Age in Europe and are nearly as ancient as textiles themselves [1]. With the evolution of synthetic dyes that are easily available at economical cost since about 150 years with moderate to excellent fastness properties, there has been a great decline in the use of natural dyes with poor to moderate fastness. But, the recent increase in environmental awareness has compelled the use of non toxic and natural dyes on textiles in order to avoid certain harmful synthetic dyes [2]. The worldwide use of natural dyes for the coloration of textiles has mainly been restricted to craftsman, small scale dyer and printer as well as small scale exporters and producers, dealing with high value ecofriendly textiles production and sales [3-5]. Dye compatibility relates to similarity and differences in rate of dyeing, color build up, and so on between two dyes combination of two dyes used or also known as binary dyes. There are different conventional methods to assess compatibility of each dyes [6-11].

Jute Printing with Natural Dyes

In order to solve the issue of environmental pollution issue due to synthetic dyes, many commercial dyes and small scale export houses are exploring the prospects of using natural dyes on a regular basis for dyeing and printing of textiles [12]. In comparison with synthetic dyes, natural dyes create shades that are very unusual, soothing and soft. Currently natural dyes are produced at commercial scale by few manufacturers. However, the number is increasing. There is a need of proper and standardized dyeing and printing methods in order to commercially utilize natural dyes without compromising quality needs of coloured textile materials. In order to achieve variety of shades having balanced colour fastness, it is felt necessary to review and reconstruct the traditional process of coloration to control each treatment, i.e., preparatory and printing process variables. A good deal of research has been done relating to the dyeing of textiles using natural dyes. However, little work has been done in the area of printing. The printing of fabrics made from natural fibres has been investigated using natural dyes from alkanet and rhubarb by adoption of the pigment printing method [13]. The resist printed natural dyed textile of Ajarkh has been studied [14]. The reactive cyclodextrin in cotton printing with henna as natural dyes has been studied [15]. Investigation has been carried out with regard to cotton fabric pretreated by chitosan and printed with natural colouring matter, curcumin [16]. The colour yield was found to increase by increasing the molecular weight of chitosan. Besides its popular use as packaging material, jute being considered as lignocellulosic golden fibre finds use in many diversified and value added products. The end uses range from wall hanging, appliance cover and curtains to apparels where aesthetic appearance and feel are important. Dyeing or printing enables to achieve the aesthetic appearance. The coloration of jute fibre is mainly attributed to the cellulosic constituents of jute fibre that account for nearly 60% of its mass. Though jute fabrics have been mostly dyed using synthetic dyes, some efforts have been taken to replace the synthetic dyes with natural dyes [17-19]. But, work related to printing of jute with natural dyes and development of a process to produce printed jute fabric with natural dyes having required fastness properties, is very scanty. Jute fabric having acceptable fastness properties by dyeing. It could be possible to achieve printed fabric having considerable wash, rub and light fastness through use of natural dyes and appropriate printing additive. Hence, in the work considered, jute fabric has been subjected to bioscouring, eco-friendly bleaching and mordanting, and subsequently printed with natural dyes extracted from roots of manjistha, bark of ratanjot and seeds of annatto. The print paste has been prepared by use of natural thickener.

The jute fabric is rendered white, bright and soft by bioscouring and bleaching and can be used for printing. The range of particle size is between 400-800 nm in the case of natural dyes obtained from manjistha, annatto and ratanjot. Colour yield and fastness properties are found better in case of printing on double mordanted bioscoured bleached jute fabric. Screen mesh size of 20 or 40 is found better in case of printing jute fabric. Wet and dry rub fastness is excellent in case of printed jute fabric using manjistha while it is good in case of annatto.

Compatibility Studies of Jute on Direct Dyes

The following are the various methods for assessment of compatibility of each dyes

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a) Colorimetric method of comparing and plotting ΔC *vs* ΔL or K/S *vs* ΔL values for two sets of progressive shades built up by dyeing with varying dye concentration in one set and with varying profile of dyeing time and temperature in second set.

b) Subjective visual evaluation of the degree of on-tone build up by a series of dyeing.

c) Prediction of compatibility by comparison of rates of dyeing (time of half dyeing) and dyeing kinetics (diffusion coeffiecients) for each individual dye, and

d) Quantitative assessment of change in hue (ΔH) with dye concentrations.

In the literature, some investigations relating to the compatibility of binary and ternary mixture of synthetic dyes can be found. However, for application of binary mixture of direct dyes applied on jute are available in literature to a very little extent [20-24]. A great problem that dyers face is the dyeing of a particular fibre, taking into account combination of various dyes in the same dye bath to achieve compound shades with varied chemical structures and functional groups of dyes. It gets further complex in the case of jute, which is a multi constituent fibre. Conventional colorimetric method of determining compatibility of dyes is a cumbersome process by comparing ΔC *vs* ΔL and K/S *vs* ΔL curves for two dyeing sets, namely by varying dyeing temperature and time profile in one set and varying dye concentration in another set. So, a simpler and easy methods needs to be adopted. Following an earlier study, a new method of relative compatibility rating test has been used in the study considered for application of direct dyes on jute [25]. The applicability/adoptability of this new method has been checked based on the calculation of colour difference index values using different proportions of dyes to obtain desired compound shades on jute fabrics. The new method will be beneficial for dyers and researchers for obtaining a predictable and uniform colour shade with maximum reproducibility.

In conventional method of compatibility test, the combinations M1 (Direct red 12B+Direct Green YG) and M5 (Direct Green YG+Direct Turquish Blue 2R) combinations show better compatibility, while M6 (Direct Yellow 5GL+Direct Turquish Blue 2R) exhibits worst compatibility amongst 6 combinations (M1-M6). However, as per newer RCR system of compatibility rating, the order of relative degree of compatibility among the selective binary mixture of dyes is:

M5>M4>M2>M6>M3>M1.

This newer method (RCR) is thus found to be simpler and more useful to determine compatibility of binary pairs of selective direct dyes for dyeing jute with binary mixture of direct dyes in various proportions for developing different compound shades on jute fabrics. This will enable the dyer an option for choice of appropriate and compatible mixture of direct dyes to match a targeted compound shade easily. Moreover, binary mixture of direct dyes applied in equal proportions, ΔC (change in chroma) values are in the following order for different binary combination, gradually showing more intense colour and higher shade depth in terms of surface colour strength:

M1<M4<M5<M2<M6<M3

In all cases the brightness index values for the selective binary pairs of direct dyes are found to increase in the following order:

M4<M3<M1<M2<M5<M6

Also for binary mixture of direct dyes applied in equal proportions, ΔH values are found in the following order, indicating the increasing heat of dyeing required for successful dyeing of the selective binary pairs:

M4<M1<M2<M5<M3<M6.

Conclusion

The whiteness and softness of the fabric is rendered by bleaching and bioscouring, which are very much essential for good printing effect. The jute fabrics are double mordanted with myrobalan (biomordant) extract and potash alum (chemical mordant). Natural dyes are extracted from seeds of annatto, roots of manjistha and bark of ratanjot by aqueous extraction method. The particle size of dyes is found in the range of 400-900nm. Mordanted jute fabrics are printed by screen printing method using different mesh sizes (20, 40, 60). Guar gum is used as thickener and urea as hygroscopic agent. After printing, steaming is done for 30 min at 100°C followed by soaping and washing. The findings reveal that the printed jute fabric with very good wash and rub fastness can be produced from natural dyes and natural thickener(guar gum) by substantive screen printing method, and these can be used as decorative, furnishing and apparel textiles. In conventional method of compatibility test, the study has been made using calorimetric by comparing ΔC *vs* ΔL or K/S *vs* ΔL for two sets of dyed samples, varying time and thermal profile in one set, and dye concentration in second set for dyeing jute fabric, with binary pairs of dyes in equal proportion. In proposed method of compatibility test, the colour difference index values are calculated for dyed jute fabrics using different proportions of binary mixture of dyes. Finally, from the difference of maximum color difference index and minimum colour difference index, the relative compatibility rating is judged. In conventional method of compatibility test, Direct red 12B+Direct Green YG and Direct Green YG+Direct T Blue 2R combinations show better compatibility, while Direct Yellow 5GL+Direct T Blue 2R exhibits worst compatibility among total six combinations studied. In case of proposed method, Direct Green YG+Direct Yellow 5GL and Direct Green YG+Direct T Blue 2R combinations show better compatibility, while Direct Red 12B+Direct Green YG combination shows fair compatibility, and Direct Yellow 5GL+Direct T Blue 2R shows moderate compatibility. Thus the results of two methods though are not exactly the same but are nearer and acceptable.

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