# Printing of jute with vegetable colour- An approach towards diversification

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## Introduction

Jute, popularly known as "Golden fibre of India" has gained immense popularity around the globe because of its bio-degradable and eco-friendly character. Apart from being eco-friendly, jute possesses the characteristics of a silky luster with high tensile strength and low extensibility. It has traditionally been used as packaging material for the transport and storage of agricultural and industrial products. A small percentage of jute products are used in diversified value-added articles and the possibility of using jute for value-added diversified products has been explored in the recent past. Government of India is giving special emphasis on re-orientation of R&D activities on jute with special thrust on value-added diversified products. The thrust of jute diversification programme includes use of jute fibre in the areas like: Handloom and Handicrafts, Industrial Applications, Jute Composites, Decorative, Food Grade Jute Products and Geo-Jute. In case of jute diversified products more focus should be given on its aesthetic appeal or exclusive designs rather than its functional performance. Dyeing and printing of jute with vegetable colour is one such approach which needs to be explored systematically and also scientifically for producing diversified value-added jute products. The present article reports dyeing and printing of jute yarn and/or fabric with vegetable colourants in absence and presence of different inorganic salts for producing eco-friendly jute diversified products and to assess different colourfastness properties of those dyed and printed fabrics.

Tea (*Camellia sinensis*) is a beverage produced from leaves of the tea plant. The chief biochemical colouring compounds present in tea liquor are theaflavin and thearubigins [1]. Marigold (*Tagetes erecta*) is a stout branching herb extensively cultivated in all over India and commonly used at religious ceremonies. The flowers mainly contain the flavonol-quercetagetol, a derivative of quercetol [2-3]. Madder dyes are hydroxyl-anthraquinones, which are extracted from the root bark of various *Rubiaceae* e.g. from madder root (*Rubia tinctorum*). The root contains approximately 1.9% of dye and many shades of red can be created with the colour extracted from madder root [3]. Indian Mahogany (*Cedrela toona*) is a high tree belonging to Meliaceae family. The bark of this tree is smooth and dark brown in colour. The bark extracts are used as astringent for wounds. The flowers contain a flavonic yellow pigment quercetol [3, 4]. Khair (*Acacia catechu*) is a small deciduous tree belonging to leguminous woods and can be used as vegetable colourants. Different shades of brown and yellow colour can be produced with the bark of Khair [4].

## Experimental

### Materials

### Jute fabric and yarn

Plain weave loom state 100% jute fabric having 50 ends/dm and 28 picks/dm with 170 g/m$^2$ in weight and jute yarns of various counts were used in this study for producing different diversified eco-friendly jute products.

### Chemicals

Laboratory reagent (LR) grade aluminium sulphate and ferrous sulphate obtained from M/s Loba Chemie Pvt. Ltd., Mumbai were used in the present study. All other chemicals used in this study were either of commercial grade or of laboratory reagent grade.

### Vegetable colourant

*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 colourants for the purpose of dyeing and printing of jute materials. All the vegetable colourants except *Camellia sinensis* were collected from locally available sources, whereas tea leaf was obtained from M/s Tata Tea, India.

## Methods

### Scouring of 100% jute yarn/fabric

Scouring is basically a process of treating jute yarn/fabric with alkali to achieve certain objectives aimed at facilitating further wet processing. Scouring of 100% grey jute yarn/fabric was done by employing sodium hydroxide (2% on weight of materials) and non-ionic detergent (5 g/l) at a temperature of 90$^0$C for 30 min keeping material to liquor ratio of 1:20. After scouring the yarn/fabric was washed thoroughly with hot water, followed by cold water.

### Bleaching with hydrogen peroxide

The scoured jute materials were bleached with hydrogen peroxide (20 g/l), sodium silicate (10 g/l), tri-sodium phosphate (5 g/l), sodium hydroxide (1 g/l) and non-ionic detergent (2 g/l) at a temperature of 85$^0$C for 2 h keeping a material to liquor ratio of 1:20. After bleaching the materials were washed thoroughly at 70$^0$C for 10 min, followed by cold wash and finally neutralized with acetic acid (2 ml/l).

### Extraction of vegetable colourants

All the vegetable colourants used in this study were either collected and/or purchased from locally available sources. Vegetable matters were dried in absence of direct sunlight for 12-16 h and then crushed (if required) before extraction. The dried and crushed materials were then used for aqueous extraction. The aqueous extraction was prepared by adding 100 g of each vegetable matters to one litre of water. The mixture was stirred, heated and kept at boiling point for 45 min, allowed to stand for 15 min and finally filtered through nylon bolting cloth. The evaporated water was replaced by fresh water so that the final volume of dye liquor can be maintained to 2 litres. The filtrates were then used as vegetable colourants.

### Dyeing of jute with vegetable colour

#### *In absence of inorganic salt*

Dyeing of jute yarn/fabric with an aqueous solution of *Camellia sinensis* (tea leaf), *Tagetes erecta* (Marigold), *Rubia tinctorum* (Manjistha), *Cedrela toona* (Mahogany) and *Acacia catechu* (Khair) was done at a material to liquor ratio of

1:20. The dye bath temperature was kept at 80$^0$C for 45 min. The dyed materials were then washed with 2 g/l non-ionic detergent at 60$^0$C for 10 min, followed by cold wash and finally dried.

### *In presence of inorganic salt*

Application of aqueous solution of vegetable colourants was also selectively done in presence of inorganic salts such as aluminium sulphate and ferrous sulphate following a post-mordanting method. In case of post-mordanting method, the dyeing was carried out in absence of inorganic salts or mordant at 80$^0$C for 45 min. The dyed yarn/fabrics were then mordanted in a separate bath at 70$^0$C for 20 min. The salt concentration for all such applications was kept at 5 g/l of the dye liquor. For both dyeing and mordanting process the material to liquor ratio was maintained at 1:20. Soaping of all the dyed yarn/fabric samples was done employing 2 g/l non-ionic detergent at 60$^0$C for 10 min. Finally the fabric samples were cold washed and dried.

## Printing of jute fabric

Printing of jute fabrics dyed with vegetable colourants was carried out with the help of print paste containing inorganic salts (5 g/1000 g of print paste) and gum indulka thickener, whereas for printing on bleached jute fabric the print paste was prepared by mixing inorganic salts, vegetable colourants and gum indulka thickener. The impressions were made with the help of wooden blocks of various designs. After printing the fabrics were dried at room temperature, followed by steaming for 10 min at a temperature of 100$^0$C in a cottage steamer. After steaming the printed fabrics were immediately washed with 2 g/l non-ionic detergent at 50$^0$C for 10 min in order to remove the gum and the strong mineral acid (Sulphuric acid) produced during the steaming process. After soaping the printed fabrics were further washed with cold water and finally dried in air.

## Assessment of colourfastness to washing

Colourfastness to washing of jute substrates dyed and printed with different vegetable colourants in absence and presence of inorganic salts was assessed in a Launder-o-meter in accordance with a method prescribed in IS: 3361-1984 (ISO-II) [5].

## Assessment of colourfastness to light

Colourfastness to light of selected jute substrates dyed with vegetable colourants was assessed on a Mercury Bulb Tungsten Filament (MBTF) lightfastness tester following a method prescribed in IS: 2454 -1984 [6].

## Assessment of colourfastness to rubbing

This was determined employing a Crockmeter following the method prescribed in IS: 766-1984 [7].

## Results and Discussion

**Table-1** shows data for colourfastness to rubbing (dry) of jute fabrics when dyed and printed with vegetable colourants in absence and presence of aluminium sulphate and ferrous sulphate. A common good dry rubbing fastness property indicates that mere deposition of the colourants on the surface of the jute fabric at the end of printing is low.

**Table-2** shows data for colourfastness to washing of jute fabrics when dyed and printed with vegetable colourants in absence and presence of inorganic salts. The rating for colourfastness to washing in absence of any inorganic salt appears to be 3 commonly, which is further improved by one point scale in presence of aluminium sulphate and ferrous sulphate. The good rating for colourfastness to washing in presence of inorganic salts is the consequence of formation and deposition of insoluble complex of the colouring component present in the vegetable colourants and the iron and aluminium within the substrate.

The rating for colourfastness to light of jute fabrics when dyed and printed with vegetable colourants in absence and presence of different inorganic salts are also given in Table-3. Use of inorganic salts produce moderate to good lightfastness rating of the dyed and printed jute substrates. Iron and aluminium with their good complex forming ability [8] can hold two or more suitable dye molecules together to form insoluble large complex, which enhanced the lightfastness rating [9, 10]. Such complexation of the coloured component within the fibre structure leads to polymerization of the dye molecules which was also responsible for improvement in lightfastness property of the printed substrates [9, 11, 12].

## Conclusions

Studies presented in the present article relate to dyeing and printing of jute yarn/fabric with *Camellia sinensis* (tea leaf), *Tagetes erecta* (Marigold), *Rubia tinctorum* (Manjistha), *Cedrela toona* (Mahogany), *Terminalia chebula* (Harda) and *Acacia catechu* (Khair) in absence and presence of different inorganic salts with the objectives of achieving an improvement in the fastness properties of the printed materials, making them higher performing and enhancing scope for their use in different value-added jute diversified products. Ferrous sulphate and aluminium sulphate when used as inorganic salts produce most balance improvements in colourfastness of the printed jute fabrics.

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## Table 1: Colourfastness to rubbing of printed jute fabric

| Inorganic salts used | Colourfastness to rubbing (dry) | | | | | |
|---|---|---|---|---|---|---|
| | ***Camellia sinensis*** | ***Tagetes erecta*** | ***Rubia tinctorum*** | ***Cedrela toona*** | ***Terminalia chebula*** | ***Acacia catechu*** |
| Nil | 4 | 4 | 4 | 4 | 4 | 4 |
| Ferrous sulphate | 4 | 4 | 4 | 4 | 4 | 4 |
| Aluminium sulphate | 4 | 4 | 4 | 4 | 4 | 4 |

## Table 2: Colourfastness to washing for printed jute fabric

| Vegetable colourants | Inorganic salts | Colourfastness to washing | | |
|---|---|---|---|---|
| | | **Change in colour** | **Staining on cotton** | **Staining on wool** |
| *Camellia sinensis* | Nil | 3 | 4 | 4 |
| | Ferrous sulphate | 4 | 4 | 4 |
| | Aluminium sulphate | 4 | 4 | 4 |
| *Tagetes erecta* | Nil | 3 | 4 | 4 |
| | Ferrous sulphate | 4 | 4 | 4 |
| | Aluminium sulphate | 4 | 4 | 4 |
| *Rubia tinctorum* | Nil | 3 | 4 | 4 |
| | Ferrous sulphate | 4 | 4 | 4 |
| | Aluminium sulphate | 4 | 4 | 4 |
| *Cedrela toona* | Nil | 3 | 4 | 4 |
| | Ferrous sulphate | 4 | 4 | 4 |
| | Aluminium sulphate | 4 | 4 | 4 |
| *Acacia catechu* | Nil | 3 | 4 | 4 |
| | Ferrous sulphate | 4 | 4 | 4 |
| | Aluminium sulphate | 4 | 4 | 4 |
| *Terminalia* | Nil | 3 | 4 | 4 |

| | | | | |
|---|---|---|---|---|
| *chebula* | Ferrous sulphate | 4 | 4 | 4 |
| | Aluminium sulphate | 4 | 4 | 4 |

**Table 3: Colourfastness to light for printed jute fabric**

| Inorganic salts used | Colourfastness to light | | | | | |
|---|---|---|---|---|---|---|
| | ***Camellia sinensis*** | ***Tagetes erecta*** | ***Rubia tinctorum*** | ***Cedrela toona*** | ***Terminalia chebula*** | ***Acacia catechu*** |
| Nil | 3 | 2-3 | 3 | 3 | 3 | 3 |
| Ferrous sulphate | 4 | 4 | 4 | 3-4 | 4-5 | 3-4 |
| Aluminium sulphate | 4 | 3-4 | 3-4 | 4 | 4 | 4 |

## *Diversified Eco-friendly Jute Products*

### *Shopping bag*

Vegetable dyed jute fabric was printed with vegetable colourant and subsequently stitched for producing the shopping bag. The printing impressions were made with the help of wooden blocks. Tea (*Camellia sinensis*) was used for dyeing purpose, whereas Harda and ferrous sulphate combination were used for printing

## *Shopping bag*

Bleached jute fabric was printed with vegetable colourant and subsequently stitched with the dyed fabric. The printing impressions were made by the help of wooden blocks and sticks. Dyeing was carried out with aqueous extraction of tea and ferrous sulphate following a post mordanting method. For printing tea and aluminium sulphate combinations were used

## *Water bottle carrier*

Bleached jute fabric was dyed with Khair (A*cacia Catechu*) and subsequently printed with Harda (*Terminalia Chebula*) and ferrous sulphate combination. The printing impressions were made by the help of wooden sticks and blocks. The handle of the bag was made of cotton thread.

## *Fancy ladies side bag*

Bleached jute fabric was dyed with Marigold (*Tagetes erecta*) and subsequently printed with Harda (*Terminalia Chebula*) and ferrous sulphate combination. The printing impressions were made by the help of wooden sticks and blocks. The handle of the bag was made with the help of wooden and ceramic balls.

## *Fancy shopping bag*

Bleached jute fabric was dyed with Manjista (*Rubia tinctorum*) and subsequently printed with vegetable colourant and inorganic salt combination. The printing impressions were made by the help of wooden blocks.

## *Weft knitted bag (Botuae and mobile cover)*

Bleached jute yarns were dyed with Manjista (*Rubia tinctorum*) and aluminium sulphate combination following a post mordanting technique. The yarns were then knitted with the help of barbed needle for producing *batuae* and mobile cover.

## *Table Mat*

Bleached jute yarns were dyed with Khair (*Acacia Catechu*) and aluminium sulphate combination following a post mordanting technique. The yarns were then knitted with the help of barbed needle for producing table mat.