

Effect of Bleaching Agents on Colour Depth of Jute Fabric Dyed with Natural Dyes

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Abstract

Raw jute fabric was subjected to two bleaching agents namely hydrogen peroxide and peracetic acid. Bleached jute fabrics were pre mordanted with alum, copper sulphate and ferrous sulphate and then dyed with four natural dyes: madder, turmeric, eucalyptus leaves and Indian almond leaves. The effect of bleaching agents on various physical properties like weight loss, tensile strength, whiteness, yellowness and brightness indices were studied. The effect of bleaching on colour development using different natural dyes was examined. Peracetic acid bleached samples were found to have high degree of whiteness with very less damage compared to hydrogen peroxide bleached samples. Peracetic acid bleached samples were found to be relatively darker.

Keywords: Jute; Bleaching; Fabric; Natural dyes

Introduction

During the past decade, increasing environmental awareness, new global agreements and international governmental regulations have been driving forces behind the renewed interest in the natural fibres. The attractiveness of a plant-based fibre comes from its high-specific strength and stiffness, natural availability and environmental friendliness [1,2].

Jute is a natural biodegradable fiber with advantages such as high tensile strength, excellent thermal conductivity, coolness, ventilation function etc. Besides its traditional usages like sackings, hessian, carpet backing, etc. jute is now-a-days being used to produce various fancy and household products. Jute is a natural fibre, its environmental friendliness remains intact where dyed with natural dyes and colour effect on this fibre is enhanced by proper bleaching [3,4].

Bleaching holds the key for successful production of diversified jute products. The primary object of jute bleaching is to improve its whiteness and to have better look after dyeing [5].

Substantial research has been carried out on the effects of different bleaching agents on jute and dyeing of jute with natural dyes but the correlation between effects of bleaching agents on dyeing performance of jute using different natural dyes is hardly available in the literature. In the present investigation, therefore an attempt has been made to study the effect of various bleaching agents on the physical properties of jute fabric as well as its effect on the dyeing properties when dyed with natural dyes.

Materials and Methods

Material

Fabric: Locally available jute fabric with the following specifications was selected for this study (Table 1).

Dyes and chemicals: Natural dyes for the study were Madder, Turmeric, Eucalyptus Leaves and Indian almond leaves. The mordants for the study were used Alum, Copper Sulphate and Ferrous Sulphate. Sodium carbonate and detergent were used for the scouring of jute fabric. Glacial Acetic acid and Hydrogen Peroxide (30%) were taken for the preparation of Peracetic acid. All the chemicals used for the study were LR grade.

Methods

Scouring: The fabric was scoured using 2 g/L of soda ash and 2 g/L of detergent keeping material to liquor ratio 1:40 at 85°C for 30 minutes. The samples were then rinsed in water to remove traces of soap and dried in shade. The scoured fabric was subjected to two bleaching systems namely hydrogen peroxide and peracetic acid bleaching.

Bleaching systems

Hydrogen peroxide: The scoured fabric was bleached with 1% (v/v) of hydrogen peroxide using 2 g/l of sodium silicate as stabilizer maintaining the material liquor ratio 1:40. The fabric was treated in this solution for 30 minutes at 50°C. The samples were then neutralized using dilute acetic acid.

Peracetic acid: Peracetic acid is prepared by reacting hydrogen peroxide with acetic anhydride or acetic acid. The most widely used method for the preparation of peracetic acid is direct, acid catalyzed reaction of 30-98% hydrogen peroxide with acetic acid. For this study, peracetic acid was prepared by reacting hydrogen peroxide (30%) with glacial acetic acid in 1:2 molar ratio at room temperature for 24 hours using sulphuric acid as catalyst. The scoured jute fabric samples were treated with freshly prepared peracetic acid for 1 hr at room temperature.

Extraction of dyes: As a natural dye source, four dyes namely Madder, Turmeric, Eucalyptus leaves and Indian Almond leaves were collected. Madder and Turmeric were taken in powdered form. Eucalyptus Leaves and Indian Almond leaves were dried in shade and then powdered. In order to extract the dye, 3% (wt/vol) of the natural source of the dye was immersed in water and was boiled for 30 minutes and then filtered. The dye extract thus obtained was directly used for dyeing of the bleached samples.

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Mordanting: The mordants used for the study were alum (10% owf), copper sulphate (4% owf) and ferrous sulphate (4% owf). The fabric samples were treated in the aqueous solution of the mordant for 30 minutes keeping material to liquor ratio 1:40. After treatment samples were squeezed and directly taken for dyeing.

Dyeing: The dyebath was prepared with the requisite amount of dye. The pre mordanted samples were dyed using exhaust method at room temperature for 10 minutes maintaining material to liquor ratio 1:40. The temperature of the dyebath was then gradually increased to boil and the dyeing was continued for 1 hour. After dyeing, the samples were thoroughly washed, rinsed and dried.

Determination of K/S: The K/S values of the dyed jute fabric samples were determined by computer colour matching system using Spectrascan 500, Premier Colour Scan, India.

Results and Discussion

Effect of bleaching agents on physical properties

After scouring the jute fabric samples were bleached with two bleaching agents namely Hydrogen Peroxide and Peracetic acid. The effect of bleaching on various physical properties like tensile strength, weight loss, whiteness, yellowness and brightness indices were investigated, the results of which are presented in Table 2. It is clear from the results that whiteness and brightness of the sample bleached using peracetic acid was better compared with the sample bleached using hydrogen peroxide. The result of whiteness is also supported by the yellowness indices which show a reversed effect. The higher weight loss of Hydrogen peroxide bleached sample caused higher loss in tensile strength compared to peracetic acid bleached sample. Similar effect was also observed by Chattopadhyay et al. [3].

The higher weight loss in case of hydrogen peroxide is because of alkaline bleaching condition. The alkaline condition causes partial removal of hemicelluloses which is a cementing material for the ultimate cells of jute fibre. The loss in hemicelluloses weakens the fibres

Fabric	Fiber content	Weave	Fabric count (yards/sq. cm)		Weight per unit area (gms/sq.mt)
			Ends	Picks	
Jute	100% jute	Plain	25	27	875.5

Table 1: Specification of the fabrics.

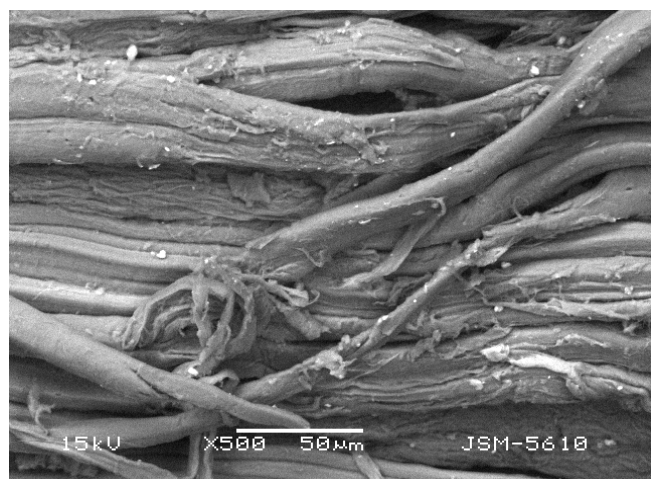


Figure 1: Scanning electron micro photograph of sample bleached with Hydrogen peroxide.

and causes reduction in tensile strength as a consequence leads to loss in weight. Peracetic acid bleaching was conducted in neutral condition; hence there was no major damage to the fibre which was reflected in tensile strength also after bleaching.

The damage to the fibre in hydrogen peroxide bleaching compared to peracetic acid bleaching can be clearly seen from the SEM photographs for these two bleached sample represented in Figures 1 and 2. The surface of peracetic acid bleached sample shows lesser physical damage compared to hydrogen peroxide bleached sample.

Effect of bleaching agents on the colour depth

The bleached samples were pre- mordanted with alum, copper sulphate and ferrous sulphate and then dyed with various natural dyes like madder, turmeric, Eucalyptus leaves and Indian almond leaves. The K/S values of the dyed samples were examined after dyeing. The results of this investigation are presented in Tables 3-5.

The values in the parenthesis indicate per cent improvement in K/S values compared to hydrogen peroxide bleaching: Peracetic acid bleached samples were darker compared to hydrogen peroxide bleached counter parts for all the natural dyes used in this study which can be attributed to better whiteness achieved in case of peracetic acid bleaching. The colour depth of Indian almond leaves was found to be much darker compared to Turmeric, Madder and Eucalyptus leaves.

The values in the parenthesis indicate per cent improvement in K/S values compared to hydrogen peroxide bleaching: The results of colour depth obtained for all the dyes using copper sulphate as a mordant are shown in Table 4. Here also the colour depths of peracetic acid bleached samples were higher for all the dyes. Samples dyed with Indian almond leaves were found to be the darkest samples among all the four dyes.

The values in the parenthesis indicate per cent improvement in K/S values compared to hydrogen peroxide bleaching: Table 5 indicates the effect of ferrous sulphate as a mordant on K/S for different natural dyes. Peracetic bleaching in general was resulted higher K/S for all the dyes. The per cent improvement in K/S values of turmeric was much higher followed by madder, Indian almond leaves and eucalyptus leaves. Like copper sulphate, in case of ferrous sulphate mordant also, the sample dyed with Indian almond leaves generated comparatively darker shade.

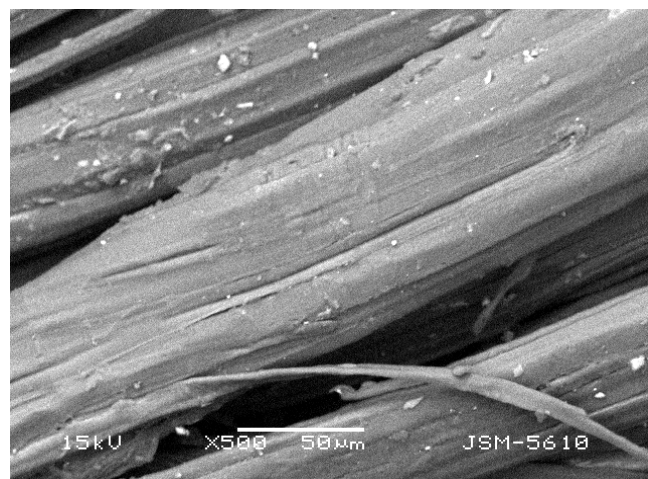


Figure 2: Scanning electron micro photograph of sample bleached with Peracetic acid bleached sample.

Sr. No.	Bleaching Agents	Physical Properties					
		Loss in weight (%)	Loss in Breaking Load (kg) (%)	Breaking Extension (mm)	Whiteness Index	Yellowness Index	Brightness Index
1.	Hydrogen Peroxide	4.5	15.1	18.4	63.22	31.92	33.79
2.	Peracetic Acid	1.7	6.5	10.7	64.15	30.87	34.81

Table 2: Effect of bleaching agents on physical properties of jute fabric.

Sr. No.	Bleaching Agents	Natural Dye			
		Madder	Turmeric	Eucalyptus Leaves	Indian Almond Leaves
1.	Hydrogen Peroxide	10.38	12.63	6.21	25.63
2.	Peracetic Acid	11.35 (9.3%)	13.43 (6.3%)	7.32 (17.8%)	27.65 (7.9%)

Table 3: Effect of bleaching agents on K/S values of Jute fabric dyed with different natural dyes for samples pre mordanted with alum.

Sr. No.	Bleaching Agents	Natural Dye			
		Madder	Turmeric	Eucalyptus Leaves	Indian Almond Leaves
1.	Hydrogen Peroxide	7.66	7.80	7.66	18.66
2.	Peracetic Acid	8.25 (7.7%)	7.84 (0.5%)	7.75 (1.2%)	18.69 (0.2%)

Table 4: Effect of bleaching agents on the K/S values of Jute fabric dyed with different natural dyes for samples pre mordanted with Copper Sulphate.

Sr. No.	Bleaching agents	Natural Dye			
		Madder	Turmeric	Eucalyptus leaves	Indian almond leaves
1.	Hydrogen Peroxide	7.22	7.65	17.33	23.75
2.	Peracetic acid	7.56 (4.7%)	8.75 (14.4%)	17.47 (0.8%)	24.56 (3.4%)

Table 5: Effect of bleaching agents on the K/S values of Jute fabric dyed with different natural dyes pre mordanted with Ferrous Sulphate.

Sr. No.	Bleaching Agents	Natural Dye											
		Madder			Turmeric			Eucalyptus Leaves			Indian Almond Leaves		
		M1	M2	M3	M1	M2	M3	M1	M2	M3	M1	M2	M3
1.	Hydrogen Peroxide	10.3	7.6	7.2	12.6	7.8	7.6	6.2	7.6	17.3	25.6	18.6	23.7
2.	Peracetic Acid	11.3	8.2	7.6	13.4	7.8	8.7	7.3	7.7	17.4	27.6	18.6	24.5

M1: Alum; M2: Copper Sulphate and M3: Ferrous Sulphate.

Table 6: Effect of the bleaching agents on K/S values of Jute fabric dyed with natural dyes using different mordants.

Table 6 summaries the effect of different mordants on color depth of all the natural dyes used as well as the effect of bleaching agents. Different dye sources exhibited different effects for the three types of mordants. For madder, turmeric and Indian almond leaves alum was found to be a better choice so far as colour depth is concerned. Ferrous sulphate mordanting exhibited much enhanced depth for the eucalyptus leaves and was found to be quite ahead compared to the other two mordants.

When the samples dyed with natural dyes were assessed visually it was found that the sample mordanted with alum and dyed with madder was brighter and redder in colour while the sample mordanted with ferrous sulphate was duller and was maroon in colour. Alum mordanted samples for turmeric dye were brighter and yellower compared to the rest of the mordants. The ferrous mordanted sample showed a greenish tint when compared to the alum mordanted sample. The samples dyed with Indian almond leaves were of greener tint.

Conclusion

Bleaching holds the key for successful production of diversified jute products. The primary object of jute bleaching is to improve its whiteness and to have better look after dyeing. This study was aimed at investigating the effect of bleaching agents on dyeing performance of jute using natural dyes.

- The whiteness and brightness of the sample bleached using peracetic acid was found to be better compared with the sample bleached using hydrogen peroxide.

- The higher loss in weight for hydrogen peroxide bleaching may be attributed to the alkaline bleaching condition which causes partial removal of hemicelluloses. However, peracetic acid bleaching was conducted in neutral condition; hence there was no major damage to the fibre which was also reflected in tensile strength.
- The relatively higher damage to the fibre in hydrogen peroxide was also manifested by the SEM microphotograph.
- For all the natural dyes used peracetic acid bleached samples were found to develop darker shades and were found to be a better choice over hydrogen peroxide.
- Different mordants exhibited different results for all the four natural dyes used. Ferrous sulphate mordanting resulted much enhanced depth for the eucalyptus leaves and was found to be quite ahead compared to alum and copper sulphate mordants, whereas for madder, turmeric and Indian almond leaves, alum was found to lead the other mordants used, so far as K/S value is concerned.

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