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Effect of pH on the Dye Absorption of Jute Fibre Dyed with Direct Dyes

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ABSTRACT

Dyeing of direct dyes, viz. Direct Yellow 29, Direct Orange 31 and Titan Yellow, has been carried out on jute fibre in the presence of sodium sulphate as an electrolyte. The effect of pH on dyeing have been studied and the results showed comparatively better dye uptake at pH 8.0. Assesment of light and wash fastness, acid and alkali spottings, and breaking strength of direct dyed jute fibre was carried out. Direct Orange 31 showed comparatively better fastness properties than other dyes.

Key words: Jute fibre, Dyeing, Light fastness, Breaking strength and Direct dye.

INTRODUCTION

Jute dyeing is a major problem in jute trade since it has an affinity for a wider range of dyestuffs due to its structural peculiarities. Jute is dyed, generally, in order to enhance its pleasing appearance by the attraction of hue and that the hue should be uniform over the whole. Dyeing does not mean only to impart attractive hue on the fibre, but to attain fast colour on it.

Depending on the demand of jute and jute products, dyeing technology of jute did not progress like other textile fibres. Due to structural peculiarities of jute, it is very difficult to obtain proper shade, correct hue and fast colour. Some investigators[1-5] describe the general methods of dyeing with different types of dyestuffs on jute fibre, but almost none of them tried to see the effect of pH of dye bath on dyeing.

In the present investigation, an effort has been exerted to dye bleached and raw jute fibres with direct dyes and to find out the optimum effect of pH of dye bath on dyeing. An assessment of light fastness, wash fastness, etc. and measurement of breaking strength of dyed jute fibre has been carried out.

EXPERIMENTAL

Materials

Corchorus olitorius (Tossa) variety of jute fibre was supplied by Rajshahi Jute Mills, Ltd., Bangladesh. The jute fibre was washed with 6.5 gm soap flake and 3.5 gm soda per litre[6] and then bleached with hydrogen peroxide[7]. Direct Yellow 29 (C.I. 19556), Direct Orange 31 (C.I. 23655) and Titan Yellow (Direct Yellow 9, C.I. 19540). Direct dyes were purchased from BDH, England. Sodium sulphate, soda ash, soap, acetic acid and hydrogen peroxide were used of reagent grade.

Method of dyeing

Jute fibre was dyed with 2% direct dyes in the presence of sodium sulphate as electrolyte at 100°C for 1 h in the fibre-liquor ratio 1:40. The pH of the dye bath was adjusted separately to 4, 7, 8 and 10 by the addition of acetic acid and soda ash, respectively. After dyeing, the fibre was rinsed thoroughly in the cold water, squeezed and soaped for 20 min. at 80°C in a dye bath containing 2 gm/ litre soap. It was then rinsed and dried. The amount of dye uptake by the jute fibre was determined by using a Spectrophotometer.

Colour fastness test

Colour fastness of dyed fibre was measured by Grey scale[8]. Fastness grade 5 is the control.

Determination of light fastness

The light fastness of the direct dyed jute fibre was determined by a Xenotester using xenon arc lamp (Xenotest 150 S of W. C. Heracus GmBh, Germany) under the following conditions: relative humidity, 78%; black panel temperature, 45°C, radiation genarated, Xenon burner surrounded by an optical filter system; and exposure period, 60 h.

Determination of wash fastness

Wash fastness of direct dyed jute fibre was determined using 5 gm/litre soap solution[9].

Determination of colour fastness to spottings with acid and alkali

Direct dyed jute fibres were combed and compressed enough to form a sheet of 10 cm X 4 cm. The specimen was spotted with two drops of sulphuric acid (50 gm/litre), acetic acid (300 gm/ litre), tartaric acid ((100 gm/litre), sodium carbonate (100 gm/litre), sodium hydroxide (50 gm/litre) and 10% ammonia solution at room temperature[10,11]. The specimen was dried at room temperature and then the change in colour of the specimen was assessed with the Grey scale.

Measurement of breaking strength

Breaking strength of the direct dyed jute fibre was measured with a Tensile strength tester (Torsees Schooper-type-OS-100, Strip method)12.

RESULTS AND DISCUSSION

Effect of pH

The dye uptake of bleached and raw jute fibres dyed with Direct Yellow 29, Direct Orange 31 and Titan Yollow from the dye bath at different pH, viz. 4.0, 7.0, 8.0 and 10.0 are listed in Table 1. Table 1 shows the percent dye uptake by both bleached and raw jute fibres increases with the increase of pH upto 8.0 and beyond which the percent dye uptake decreases. The possible explanation is that jute fibre acquires a negative charge when immersed in water. Conversely, the negative charge ions of a direct dye in solution will be repelled by the surface potential of cellulose and this potential barrier will have to be overcome before the ions can enter the fibres. Increase of pH by addition of soda ash and electrolyte lowers the repulsion due to the similar charges between the charged fibre surface and coloured dye anions by imparting oppositely charged ion with the charged dye anion, thus by overcoming the potential barrier, improve dyeability[13,14]. It is observed from the Table 1 that the percent dye uptake of bleached jute fibre is comparatively higher than that of raw jute fibre. This is probably due to increase in free carboxyl content in the jute fibre on bleaching. The positively charged sodium ions of electrolyte and soda ash can be attracted toward the negatively charged surface of bleached jute fibre, and hence, neutralize of some of its repulsive effect towards anions. Thus the dye anions are present in the solution are enable to approach and enter the fibres more readily[14].

Light fastness

From the Table 2, it is seen that Direct

Table 1: Dye uptake of jute fibre dyed with direct dyes under different pH of dye baths

pH of dye bath →	Dye uptake, %							
	Bleached jute fibre				Raw jute fibre			
	4.0	7.0	8.0	10.0	4.0	7.0	8.0	10.0
Direct Yellow 29	40.5	65.0	78.4	71.5	36.9	61.0	72.4	69.7
Direct Orange 31	45.0	70.2	80.5	76.1	40.2	67.8	78.5	75.2
Titan yellow	20.5	32.1	46.0	37.5	17.7	28.6	37.8	35.0

Orange 31 exhibits very good colour fastness with both bleached and raw jute fibres and Direct Yellow 29 and Titan yellow exhibit good colour fastness with bleached jute fibre only on exposure to light. All dyes do not possess the same degree of fastness to light on jute. Again, the different assistants used in dyeing have a marked effect on the colour fastness of the fibre and may tend to minimize or accentuate the apparent fatting of due stuffs. It is observed from Table 2 that light fastness of dyed bleached jute fibre is comparatively better than that of dyed raw jute fibre. The possible explanation is that the raw jute contains high amount of lignin than bleached jute fibre. The exposed dyes gain sensitivity action on photo-oxidation process which is initiated by lignin in presence of light and it causes the rapid change in colour of dyed fibre[15].

Table 2: Light fastness of jute fibre dyed with direct dyes

Exposure period, hr	Light fastness grade					
	Bleached jute fibre			Raw jute fibre		
	Direct Yellow 29	Direct Orange 31	Titan yellow	Direct Yellow 29	Direct Orange 31	Titan yellow
0	5	5	5	5	5	5
60	4	4-5	4	3	4	3

Wash fastness

It is seen from the Table 3 that the wash fastness of Direct Orange 31 dyed jute fibre exhibits good. This supports the strong and stable dye-fibre covalent linkage. It is observed from the Table that wash fastness of dyed bleached jute is comparatively better than that of dyed raw jute.

Table 3: Wash fastness of jute fibre dyed with direct dyes

Washing temp °C	Light fastness grade					
	Bleached jute fibre			Raw jute fibre		
	Direct Yellow 29	Direct Orange 31	Titan yellow	Direct Yellow 29	Direct Orange 31	Titan yellow
0	5	5	5	5	5	5
100	3	4-5	4	2-3	3-4	3

Fastness to acid and alkali spottings

The data on colour fastness to acid and alkali spottings of jute fibre dyed with direct dyes are presented in Table 4. It is observed from the Table that the colour fastness to spotting of dyed bleached jute fibre with acetic acid, tartaric acid and ammonium hydroxide shows excellent results. Again, the colour fastness to spotting of dyed bleached jute fibre is comparatively better than that of dyed raw jute fibre.

Table 4: Colour fastness and change in colour of jute fibre dyed with direct dyes to acid and alkali spottings

Chemicals	Fastness grade and colour					
	Bleached jute fibre			Raw jute fibre		
	Direct Yellow 29	Direct Orange 31	Titan yellow	Direct Yellow 29	Direct Orange 31	Titan yellow
Unspotted	5	5	5	5	5	5
Sulphuric acid	Black	3	2	Black	2-3	2
Acetic acid	5	5	4	3	4	3
Tartaric acid	4	5	4	3	3-4	3
Sodium hydroxide	4	4-5	3	3	4	3-4
Sodium carbonate	4-5	5	4	3-4	4	4
Ammonium hydroxide	5	5	5	4-5	4-5	4-5

Breaking strength

From the Table 5, it is observed that the breaking strength of direct dyed bleached and raw jute fibre decreases with increasing the exposure time. It is seen from the Table 5 that the loss in breaking strength of dyed raw jute is comparatively higher than that of dyed bleached jute. This is due to the presence of higher lignin in raw jute[15].

Table 5: Loss in breaking strength of jute fibre dyed with direct dyes on exposure to light

Exposure period, hr	Fastness grade and colour					
	Bleached jute fibre			Raw jute fibre		
	Direct Yellow 29	Direct Orange 31	Titan yellow	Direct Yellow 29	Direct Orange 31	Titan yellow
0	39.20	36.50	38.50	37.00	34.80	37.20
60	32.35	30.67	31.25	28.60	26.00	27.00
	Loss in breaking strengh, %					
	17.47	15.97	18.83	22.70	25.29	27.42

CONCLUSIONS

On the basis of results obtained from the investigations, the following conclusions may be drawn:

1. Dye uptake by jute fibre increases with the increase of pH to a certain value and then decreases with further increase of pH. So, pH has a great effect on dye absorption of jute fibre. Again, bleached jute fibre absorbs higher amount of dye than that of raw jute.
2. The colour of dyed jute fibre become fade on exposure to light and on washing with soap solution. Light and wash fastnesses of dyed bleached jute fibre is comparatively better than that of dyed raw jute fibre. The effects of

acid and alkali on dyed jute fibre are satisfactory in most of the cases, but in some cases it gives unwanted results by fading or changing colour.

3. The loss in breaking strength of dyed bleached jute fibre is comparatively lower than that of dyed raw jute fibre. The lower loss in breaking strength of dyed bleached jute fibre is due to the lower amount of lignin present in it.

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