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Effect of Salts on Dyeing into Jute with Reactive, Direct, Basic and Mordant Dyes

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ABSTRACT

Bleached jute has been dyed with reactive, direct, basic and mordant dyestuffs in presence of $Al_2(SO_4)_3$, Alum, Na_2SO_4, NaCl, $MgCl_2$, $FeSO_4$, $Cr_2(SO_4)_3$, $CuSO_4$, $(CH_3COO)_2Mg$, $ZnSO_4$, $NiSO_4$ $(CH_3COO)_2Ca$ salts as an electrolytes separately. The dye absorption, light and wash fastness properties of dyed bleached jute fibers has been studied. The dye absorption, light and wash fastness were better with aluminum sulfate for reactive and basic dyes, sodium sulfate for direct dyes and chromium sulfate for mordant dyes.

Keywords: Jute, bleaching, salts, dye absorption, color fastness

INTRODUCTION

Reactive, direct, basic and mordant dyes are available synthetic dyes amongst the commercial dye range. They are still the brightest and the most brilliant in hue of the synthetic dyes and widely used for the dyeing of cotton, silk, jute, kenaf, flax. Dyes of this type (except basic) are anionic in character and in general owe their water solubility to the presence of sulfonate groups ($^-HSO_3$). However, since jute itself adopts an anionic surface charge in water, these dyes have low intrinsic affinity for the fiber. The repulsive charge between dye and jute fiber can be overcome by adding a salts such as sodium chloride, which has the effect of screening the surface charge on the fiber [1]. Jute fiber possesses good affinity than cotton with reactive, direct, basic and mordant dyes due to the presence of lignin. But from the practice, it has been observed that they possess very poor color fastness on jute when sodium chloride used as an electrolyte. A number of attempts have been made to modify the jute fiber vinyl monomers to improve of the color fastness properties [2-7]. A few efforts were made to improve the light fastness which is the major problem for jute when it is exposed to sun light [8]. But no researcher tried to find out better salt (electrolyte) for the improvement of dye absorption and the color fastness properties.

In the present investigation an effort was made to improve dye absorption and color fastness properties of Reactive Red 120, Reactive Blue 5, Reactive Brown 10, Reactive Orange 14 for reactive dyes, Direct Yellow 29, Direct Orange 31 Direct Yellow 9, Direct Red 28 for direct dyes, Auramine O, Magenta MB, Chrysoidine Y, Crystal Violet for basic dyes and Dimond Black Gurr, Erichrome Blue Black SE, Mordant Red 19 and Anthacene Brown for mordant dyes applying on bleached jute fiber in presence of $Al_2(SO4)_3$, Alum, Na_2SO_4, NaCl, $MgCl_2$, $FeSO_4$, $Cr_2(SO_4)_3$, $CuSO_4$,

$(CH_3COO)_2Mg$, $ZnSO_4$, $(CH_3COO)_2Ca$, $NiSO_4$ salts as a electrolytes. An assessment of light and wash fastness of dyed bleached jute has been done.

EXPERIMENTAL

Materials

Bleached jute fibers were used as material for the investigation. Reactive Red 120, Reactive Blue 5, Reactive Brown 10, Reactive Orange 14, Direct Yellow 29(C.I. 1956), Direct Orange 31(C.I. 23655) Direct Yellow 9 (C.I. 1954) and Direct Red 28 (C.I. 22120), Auramine O, Magenta MB(C.I. 42500), Chrysoidine Y(C.I. 11270), Crystal Violet (C.I. 42555), Dimond Black Gurr (C.I. 15710), Erichrome Blue Black SE (C.I.16680), Mordant Red 19 , Anthacene Brown, $Al_2(SO4)_3$, Alum, Na_2SO_4, NaCl, $MgCl_2$, $FeSO_4$, $Cr_2(SO4)_3$, $CuSO_4$, $(CH_3COO)_2Mg$, $ZnSO_4$, $NiSO_4$ $(CH_3COO)_2Ca$ were obtained from commercial sources (SIGMA and BDH) and were used as received. All other chemicals used were of C.P. grade and were used as such without further purification.

Scouring and bleaching: In order to remove the wax, oil, resin and coloring matter from the fiber, first, all fibers were scoured by standard method with a solution of 4 % sodium carbonate, 1% sodium hydroxide and 0.5 % wetting agent at 75° C for 0.5 hour [1]. It was then bleached by standard method in Laundering Ometer with 2.1 % hydrogen peroxide together with 6 % sodium silicate and 0.5% sodium carbonate to maintain pH 11 initially. Percentage was based on the weight of the material, in the liquor ratio of 15:1. Bleaching was continued for 1.5 hour at 95°C. It was then washed and dried [9].

Dyeing

The dye bath was prepared by 2.5% of Reactive Red 120, Reactive Blue 5, Reactive Brown 10, Reactive Orange 14, Direct Yellow 29, Direct Orange 31 Direct Yellow 9, Direct Red 28, Auramine O, Magenta MB, Chrysoidine Y, Crystal Violet, Dimond Black Gurr, Erichrome Blue Black SE, Mordant Red 19 and Anthacene Brown separately with 0 .1% wetting agent based on the weight of the material and 80g/l salt and 10g/l soda ash, in the liquor ratio was 30:1. Sample was added to each dye bath and dyeing was commenced after 5 min at room temperature. The temperature was then raised to 80 °C at a rate of 1.5 °C/min. Dyeing was continued at this temperature for 50 min before cooling to 70 °C at a rate of 3 °C/min. The dyed sample were rinsed thoroughly in cold and hot water and finally distilled water and then dried in air oven [10].

Fastness testing

The color fastness of the dyed fibers to laundering and light were assessed using AATCC test methods [11]. Fastness to laundering was evaluated by AATCC Method 61-1996 (2A) using an Atlas Launder Ometer .Fastness to light was evaluated by AATCC Method 16E using an Atlas CI 3000+ Xenon Weather ometer. The samples were each exposed to 80 AATCC Fading Units, corresponding to 84.8 h continuous exposure under a xenon lamp at an irradiance power of 1.1 W/m2/nm at 420 nm. The grey scale was used for color change and for staining, giving color difference.

RESULTS AND DISCUSSION

From the table 1, 2 and 3, it is observed that dye absorption by bleached jute fiber is maximum and light and wash fastness are greater when jute fiber is dyed with aluminum sulfate for reactive and basic dyes, sodium sulfate for direct dyes and chromium sulfate for mordant dyes. The probable explanation is that cellulosic (jute) fibers immersed in water acquire a negative charge at their surface. Conversely the negative charge ions in solution of a reactive, direct and mordant dye will be repelled by the surface potential of the cellulose and this potential barrier will have to be overcome before the ions can enter the fibers. Addition of a salt, such as $Al_2(SO_4)_3$,

Alum, Na_2SO_4, NaCl, $MgCl_2$, $FeSO_4$, $Cr_2(SO4)_3$, $CuSO_4$, $(CH3COO)_2Mg$, $ZnSO_4$, $(CH_3COO)_2Ca$, $NiSO_4$, lower the repulsion, due to the similar charges between the charged fiber surface and colored dye anions, by imparting oppositely charged ion with the charged dye anion, thus by overcoming the potential barrier, improve dyeability[10].The presence of a salts in the dyebath decreases the membrane potential of cellulose, reduces the repellency of cellulose and dye particles with the same charges and also improves dyeability[12].

From the experiments, it was also observed that bright and uniform shades were produced when bleached jute fiber was dyed in presence of aluminum sulfate for reactive and basic dyes, sodium sulfate for direct dyes and chromium sulfate for mordant dyes.

CONCLUSIONS

The dye absorption and color fastness properties of bleached jute fiber has been evaluated in presence of twelve salts by using Reactive Red 120, Reactive Blue 5, Reactive Brown 10, Reactive Orange 14 for reactive dyes, Direct Yellow 29, Direct Orange 31 Direct Yellow 9, Direct Red 28 for direct dyes, Auramine O, Magenta MB, Chrysoidine Y, Crystal Violet for basic dyes and Dimond Black Gurr, Erichrome Blue Black SE, Mordant Red 19 and Anthacene Brown for mordant dyes. The dye absorption, light and wash fastness of dyed bleached jute fiber had better impact with aluminum sulfate for reactive and basic dyes, sodium sulfate for direct dyes and chromium sulfate for mordant dyes. The dye absorption and color fastness properties of salts are in the order of $Al_2(SO_4)_3$>Alum>Na_2SO_4>NaCl> $MgCl_2$> $FeSO_4$> $Cr_2(SO_4)_3$> $CuSO_4$> $(CH_3COO)_2Mg$ >$ZnSO_4$> $(CH_3COO)_2Ca$> $NiSO_4$ for reactive and basic dyes, Na_2SO_4>NaCl> $Al_2(SO_4)_3$>Alum> $ZnSO_4$> $MgCl_2$> $CuSO_4$> $FeSO_4$> $Cr_2(SO4)_3$>$(CH_3COO)_2Ca$> $NiSO_4$> $(CH_3COO)_2Mg$ for direct dyes and $Cr_2(SO4)_3$> $MgCl_2$> $NiSO_4$> $Al_2(SO_4)_3$>Alum>$CuSO_4$> $ZnSO_4$> Na_2SO_4>NaCl>>$(CH_3COO)_2Ca$>>$(CH_3COO)_2Mg$> $FeSO_4$ for mordant dyes.

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Table 1: Effect of salts on dyeing of bleached jute with reactive, direct, basic and mordant dyes

Dyes Used	Dye Absorption %											
	Salts (electrolyte) Used											
	$Al_2(SO4)_3$	Alum	Na_2SO_4	NaCl	$ZnSO_4$	$NiSO_4$	$Cr_2(SO4)_3$	$MgCl_2$	$CuSO_4$	$FeSO_4$	$(CH3COO)_2Ca$	$(CH3COO)_2Mg$
Reactive Red 120	68.50	55.10	45.00	42.45	15.07	13.10	20.00	26.40	18.30	21.16	15.00	17.10
Reactive Blue 5	36.80	32.20	29.20	28.00	12.70	10.00	8.25	28.50	13.00	12.25	9.50	10.80
Reactive Brown 10	31.50	27.30	26.00	24.90	10.50	8.20	10.08	25.85	11.35	11.00	8.00	9.56
Reactive Orange 14	64.50	55.10	40.20	38.00	21.30	16.00	18.15	26.40	15.00	18.40	16.50	15.80
Direct Yellow 29	48.00	47.20	78.40	75.38	48.10	25.30	30.00	40.25	38.20	36.00	26.10	24.30
Direct Orange 31	43.25	42.00	72.40	64.80	55.00	24.00	19.20	36.05	32.90	35.10	23.00	20.80
Direct Yellow 9	29.30	27.85	46.00	40.50	30.09	16.35	12.00	25.00	21.25	23.60	13.50	11.90
Direct Red 28	49.30	47.10	96.50	85.30	50.20	42.00	30.50	45.00	32.19	34.28	28.00	26.54
Auramine- O	85.75	76.80	57.00	52.94	34.00	30.50	42.70	50.20	35.10	37.00	29.25	30.00
Magenta	95.00	92.11	61.50	65.20	37.50	33.10	48.00	55.30	41.00	39.50	31.00	32.15
Chrysoidine Y	75.25	70.84	60.80	58.10	30.00	28.22	40.00	50.12	35.60	32.00	22.00	23.80
Crystal Violet	96.50	95.40	78.00	70.12	40.15	38.00	52.30	58.30	44.00	41.70	34.25	36.00
Dimond Black G	25.00	23.50	18.00	18.50	21.00	28.00	47.50	38.10	23.40	15.30	17.00	17.25
Erichrome Blue Black SE	6.20	6.15	5.80	5.60	6.00	7.25	11.00	8.95	6.50	4.90	5.00	5.00
Mordant Red 19	30.28	27.45	22.50	20.00	24.05	35.00	51.60	40.35	28.00	19.30	21.10	23.40
Anthacene Brown	22.00	20.15	18.35	17.20	20.50	25.80	39.00	34.20	21.70	13.75	15.90	16.00

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Table 2: Light fastness of bleached jute dyed with reactive, direct, basic and mordant dyes

Dyes Used	Light Fastness (Control grade 5)											
	Salts (electrolyte) Used											
	$Al_2(SO4)_3$	Alum	Na_2SO_4	NaCl	$ZnSO_4$	$NiSO_4$	$Cr_2(SO4)_3$	$MgCl_2$	$CuSO_4$	$FeSO_4$	$(CH3COO)_2Ca$	$(CH3COO)_2Mg$
Reactive Red 120	4-5	4	2-3	3-4	3	3	Magenta	3	Light Violet	1-2	3	3
Reactive Blue 5	4	3-4		3	3	3-4	3	3	2-3	3	3	2-3
Reactive Brown 10	4-5	4	2	3	2-3	3-4	2-3	3	2-3	Blackish Brown	3	2-3
Reactive Orange 14	3-4	3	3	3	2-3	3	2-3	3-4	2-3	2-3	2	3
Direct Yellow 29	3-4	3-4	4	3-4	3-4	4	Chocolate	3	Blackish Yellow	Blackish Yellow	3-4	3
Direct Orange 31	3	3	4-5	4	3-4	3	3	3	Blackish Orange	Blackish Orange	2-3	3
Direct Yellow 9	3-4	3	4-5	3-4	3	3	2-3	3	3	3	3	3
Direct Red 28	Brown	Brown	4	3-4	Blackish Red	Pink	Brown	Pink	Brown	Brown	Pink	Pink
Auramine O	4	4	4	3-4	3	3-4	3-4	3-4	3-4	Blackish Yellow	Blackish Yellow	Blackish Yellow
Magenta	4	4	3-4	3-4	3-4	3	Blackish Red	3-4	3-4	4	3-4	3-4
Chrysoidine Y	4	4	3-4	3-4	3-4	3	3-4	3-4	2-3	2-3	2-3	2-3
Crystal Violet	4	3-4	3-4	3-4	3-4	3	3-4	3-4	3-4	3-4	3-4	3
Dimont Black G	3-4	2-3	3-4	3-4	3-4	3-4	4	3-4	4	1-2	2	3
Erichrome Blue Black SE	2-3	2-3	1-2	2	1	1-2	3-4	2	2	Chocolat	2	2-3
Mordant Red 19	3-4	2-3	2-3	3	3	3-4	4-5	3-4	3-4	Golden	3-4	3-4
Anthacene Brown	2-3	3-4	3-4	3-4	3	3-4	4	3-4	3-4	3-4	3-4	3-4

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Table: 3: Wash fastness of bleached jute fiber dyed with reactive, direct, basic and mordant dyes

Dyes Used	Wash Fastness (Control grade 5)											
	Salts (electrolyte) Used											
	$Al_2(SO4)_3$	Alum	Na_2SO_4	NaCl	$ZnSO_4$	$NiSO_4$	$Cr_2(SO4)_3$	$MgCl_2$	$CuSO_4$	$FeSO_4$	$(CH3COO)_2Ca$	$(CH3COO)_2Mg$
Reactive Red 120	4	3	2-3	2-3	2	2	2	2-3	2	2	2	2
Reactive Blue 5	3-4	3	2	2	1-2	1-2	1-2	2	2	1-2	1-2	2
Reactive Brown 10	3-4	3	2-3	2-3	2	1-2	1-2	2-3	2	2	2	2
Reactive Orange 14	3-4	3	2-3	2	2	1-2	1-2	2	2	1-2	2	2
Direct Yellow 29	2	2	3	2-3	2	1-2	1-2	2	1-2	1-2	1-2	1-2
Direct Orange 31	2-3	2	3-4	3	2	1-2	1-2	2	1-2	1-2	1-2	1-2
Direct Yellow 9	3	2-3	4	3-4	2-3	1-2	1-2	2-3	2	2	2	2
Direct Red 28	3	3	4	3-4	2-3	2	2	2-3	2	2	2	1-2
Auramine -O	4	3	2-3	2	1-2	1-2	1-2	2	1-2	1-2	1-2	1-2
Magenta	3-4	3	2-3	2-3	2	1-2	1-2	2-3	2	2	1-2	1-2
Chrysoidine Y	3	2	2	1-2	1-2	1-2	1-2	1-2	1-2	1-2	1-2	1-2
Crystal Violet	3-4	3	2-3	2-3	1-2	2	1-2	2-3	2	1-2	2	2
Dimont Black G	3	3	2-3	2-3	3	3	5	3-4	2-3	2-3	2	2
Erichrome Blue Black SE	3	2-3	2	2	2-3	3	4	3	2	2	2	2
Mordant Red 19	2-3	2-3	2	2	2-3	2-3	4	3	2	2	2	2
Anthacene Brown	3	3	3	2-3	2	3-4	4	3-4	2	2	2	2

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