NC STATE UNIVERSITY
JTATM
JOURNAL OF TEXTILE AND APPAREL, TECHNOLOGY AND MANAGEMENT

Volume 4, Issue 4, Summer2005

Study of Color Fastness Properties onto Bleached Sulfonated Jute-cotton Blended Fabrics with Basic Dyes

M. A. Salam
Department of Applied Chemistry & Chemical Technology
University of Rajshahi, Rajshahi-6205, Bangladesh

Dr. Abdus Salam, 1200 N 33 Street # S,
Linclon, NE 68503 Phone: 402-617-7855,
Email: asalam_69@yahoo.com

ABSTRACT

Raw jute fiber has been sulfonated with sodium sulfite in presence of ethylinediamine (EDA) and blended with 40% cotton for production of fine yarn and fabric. Bleached raw jute fiber, bleached sulfonated jute fiber, bleached sulfonated jute-cotton blended fabric and bleached cotton fabric has been dyed with basic dyes (e.g. Crystal Violet, Chrysodine Y, Auramine O and Magenta). The light and wash fastness of the dyed sample has been studied. Bleached sulfonated jute fiber and bleached sulfonated jute-cotton blended fabric showed much better wash fastness, less staining and resistance to photo fading than that of bleached raw jute fiber, and it was almost as same as bleached cotton fabric. Magenta dye showed better light and wash fastness than other dyes. On exposure to UV, light loss in breaking strength of bleached sulfonated jute-cotton blended fabrics with Magenta is minimum in comparison with other dyes.

Keywords: Sulfonation, jute, jute-cotton blended, color fastness and breaking strength.

Introduction

Basic dyes are available as cheap synthetic dyes amongst the commercial dye range. They are still the brightest and the most brilliant in hue of the synthetic dyes (Basic Dyestuffs, 1951). They have no direct affinity for cellulose. But jute fiber possesses good affinity for basic dyes due to the presence of lignin (12%) and hemicellulose containing peripheral–COOH in the fiber and requires no mordanting prior to dyeing. Their tinctorial power is very high. But from the practice, it has been observed that they possess very poor light fastness on jute. Some investigators (Carpmaels, 1942; Carpmaels, 1928) were able to improve the light fastness of cellulose dyeing by forming lake with basic dyes. But they are of very limited use. The fastness to light of lakes produced with acid dyestuffs was improved which contain both sulpho groups and amino groups or with basic dyes by the use of phospho-tungsto-molybdenum compounds. In the study of the physical state of dyes upon their light fastness, some investigators (Richards, 1936) also worked with basic dyes and two lakes, one from an exact precipitation with phospho-tungstic acid and the other one from a precipitation with phospho-molybdic acid in order to make cellulosic dyed material photostable. A formulation was invented for simultaneous dyeing and crosslinking of cellulosic fabrics using dimethylol dihydroxy ethylene urea (DMDHEU), the acid catalyst and basic dyes (Harper, 1976). Methods of applications, economic importance and structure of more than 100 of cationic dyes were described (Roderich, 1984). The original basic dyes were based on acridine, azine, oxazine, thiazine, azo, triaryl methane and xanthene chromophores (Trotman, 1984; Nunn, 1979; Color Index 1976). Besides these, many workers carried out experiments with various kinds of dyes and applied those to jute. Some investigators (Patro**,** 1971; Hossain, 1989) observed the effects of various metal salts on color fastness in dyeing of jute with basic, acid, direct and sulphur dyes. Research on dyeing of raw and bleached jute with Catechu Brown dye using chromium sulphate, alum, and copper sulphate as mordants was carried out by some workers (Sayeed, 1987) and found improvement of wash and light fastness. Some workers (Hossain, 1990) studied the dyeing nature and color fastness of dyed jute followed by modification with a mixture of metal salts as modifier and also studied the optimum conditions of dyeing of jute with basic dyes and their fastness under different influences (Hossain,1990). From the above studies it seems clear that some works have been done on the effect of different factors on the dye up-take of jute fiber. Most of the researchers carried out research to describe the methods of dyeing jute with different types of dyestuffs. A few efforts were made to improve the light fastness which is the major problem for jute when it is exposed to sunlight. But no researcher tried to sulfonation of jute fiber for improvement of the color fastness properties such as wash and light fastness of jute fiber.

In view of the above situation, an attempt was under taken to carry out a research for the improvement of color fastness properties of basic dyes e.g. Crystal Violet, Chrysodine Y, Auramine O and Magenta applying on bleached sulfonated jute-cotton blended fabric. An assessment of light and wash fastness of bleached sulfonated jute-cotton blended fabric has been done. The result has been compared with that of bleached raw jute fiber, bleached sulfonated jute fiber and bleached cotton fabric.

J T A T M

Experimental Materials

Bleached raw jute, bleached sulfonated jute, loom state bleached sulfonated jute-cotton blended (BSJCB) fabric and bleached cotton fabric were used as material for the investigation. Four basic dyes, Crystal Violet (C. I. 6352), Chrysodine Y (C.I. 11270), Auramine O (C.I. 41000) and Magenta (C. I. 2359) were obtained from commercial sources (BDH-England) and were used as received. All other chemicals used were of C.P. grade and were used as such without further purification.

Production of fabric

Raw jute fiber was sulfonated with 12% sodium sulfite, 0.3% ethylinediamine (EDA) and 4% soda ash (owf) at 160°C for 3 hour (Janson,1966). Sulfonated jute fiber was blended with 40% cotton for the production of fine yarn and 60 × 60 plain-woven fabric.

Scouring and bleaching

In order to remove the wax, oil, resin and coloring matter from the fiber, first, all fibers and fabric was 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 (Trotman, 1984). It was then bleached by standard method in laundering ometer with 7 % hydrogen peroxide (30%, 100 volume) 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 fiber-liquor ratio of 1: 15. Bleaching was continued for 1.5 hour at 95°C. It was then washed and dried (Ibrahim, 2002).

Dyeing

The dye bath was prepared by 2% Crystal Violet and 2.5% Magenta separately with 0 .1% wetting agents and 8% aluminum sulfate based on the weight of the material. In the fiber–liquor ratio was 1:20. Sample was added to each dye bath and dyeing was commenced after 5 min at room temperature. The temperature was then raised to 90 °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 distillated water and then dried in air oven (Salam,2002).

Fastness testing

The color fastness of the dyed fibers and fabrics to laundering and light was assessed using AATCC test methods (AATCC Technical Manual, 2000). Fastness to laundering was evaluated by AATCC Method 61 (2A) using an Atlas Launder Ometer. Multifibre fabric was employed for the evaluation of staining on cotton. Fastness to light was evaluated by AATCC Method 16E using an Atlas CI 3000+ Xenon Weatherometer. 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.

Breaking Strength testing

Breaking strength of dyed bleached sulfonated jute-cotton blended fabrics were tested according to ASTM method D 2524-94

Results and Discussion

The color change of dyed fibers and fabrics after laundering is summarized in Table 1 in terms of the grey scale rating. In all cases, bleached sulfonated jute-cotton blended fabric was better than that of bleached sulfonated jute fiber and bleached raw jute fiber, and almost as same as bleached cotton fabric. Besides, bleached sulfonated jute fiber was significantly better than bleached raw jute fiber. This can be explained by the fact that the van der waals forces linking between the dyes and sulfonated jute fiber are much stronger than the raw jute fiber. Table 2 shows the staining on the adjacent undyed multi fabrics caused by the dyed fibers and fabrics during laundering. The jute fiber treated with sodium sulfite in presence of ethylenediamine and dyed with basic dyes produced less staining over untreated jute fiber, since the strong ionic interaction between the dye and sulfonic group reduced the removal of dye from the fibers. Table 3 summarizes the light fastness properties of dyed fibers and fabrics. In all cases bleached sulfonated jute-cotton blended fabric was better than that of bleached sulfonated jute fiber and bleached raw jute fiber and same as bleached cotton fabric.

J T A T M

Table 1: Wash fastness of bleached sulfonated jute-cotton blended fabrics dyed with basic dyes.

Sample	Gray scale rating			
	Crystal Violet	Magenta	Chrysodine Y,	Auramine O
Bleached raw jute fiber	2	2-3	2	1-2
Bleached sulfonated jute fiber	3	4	3	2-3
Bleached sulfonated jute-cotton blended fabrics	3-4	4-5	3-4	3
Bleached cotton fabrics	4-5	4-5	4	3-4

Table 2: Staining on cotton caused by dyed fibers and fabrics.

Sample	Gray scale rating			
	Crystal Violet	Magenta	Chrysodine Y,	Auramine O
Bleached raw jute fiber	3	3-4	2-3	2
Bleached sulfonated jute fiber	3-4	4	3	2-3
Bleached sulfonated jute-cotton blended fabrics	4	4-5	4	3
Bleached cotton fabrics	4-5	4-5	4	4

Table 3: Light fastness of bleached sulfonated jute-cotton blended fabrics dyed with basic dyes.

Sample	L value			
	Crystal Violet	Magenta	Chrysodine Y	Auramine O
Bleached raw jute fiber	1-2	2	1-2	1
Bleached sulfonated jute fiber	2-3	3-4	2-3	2-3
Bleached sulfonated jute-cotton blended fabrics	3-4	4	3	3
Bleached cotton fabrics	3-4	4	3-4	3

It is observed from Table 3 that light fastness of bleached sulfonated jute fiber was much better with that of bleached raw jute fiber. This happens, probably, due to the presence of high amount (10%) of lignin content in bleached raw jute fiber than in the bleached sulfonated jute fiber. The high reactive groups present in lignin are phenolic hydroxyl groups (Chatterjee, 1975). Lignin is highly sensitive to the action of light. When UV-light falls upon dyed bleached raw jute fiber, the phenolic hydroxyl groups of lignin in jute created free radicals. These free radicals undergo transformation into quinoid structures and showed yellowing on surface of fiber thus causing fading of dyed fiber (Callow, 1949). Conversely, dyed bleached sulfonated jute fiber contains minor amount (5.35%) of lignin and above 60% phenolic hydroxyl groups were blocked by $^{-}HSO_3$. Therefore after sulfonation when the fiber is subjected to light in presence of atmospheric oxygen, photo-yellowing can not be accelerated as much as bleached raw jute fiber. We can explain it another way. This possibility is due to the mechanism of the light action produced by the dye on the fiber. An intensive oxidation of the fiber is due to the capacity of the dye molecule, excited by the absorption of the short wave or UV light, to be reduced because of the hydrogen contain in cellulose. As a result of further oxidation of the reduced dye by the oxygen of the air, an intermediate from dye-hydroperoxide may be formed which also capable of oxidizing the fiber (Zollinger, 2003).

J
T
A
T
M

Table 4: Loss in breaking strength of dyed bleached sulfonated jute-cotton blended fabrics on exposure to UV light.

Sample	Loss in breaking strength,%			
	Crystal Violet	Magenta	Chrysodine Y	Auramine O
Bleached raw jute fiber	37. 50	34.20	35.10	38.00
Bleached sulfonated jute fiber	15.80	15.25	16.70	17.50
Bleached sulfonated jute-cotton blended fabrics	12.15	11.45	12.50	12.70
Bleached cotton fabrics	10.60	9.20	10.95	11.25

It is seen from Table 4, that the percent loss in breaking strength of dyed bleached sulfonated jute-cotton blended fabric was lower than that of bleached sulfonated and raw jute and higher that of bleached cotton fabrics. The plausible explanation of such behavior is that the photo-oxidative degradation is initiated by lignin which acts as a sensitizer and causes degradation of cellulose in all possible manners through the formation of hydrogen peroxide (Egerton, 1949). The reaction involved in photo-chemical degradation of jute is mainly oxidative in nature and on prolong exposure to UV light the constituent of cellulose chain are gradual attack and ultimately broken down into the smaller fragments, as a result, breaking strength of jute decreased.

Conclusion

The dyeing fastness properties of bleached sulfonated jute-cotton blended fabric has been evaluated using basic dyes, Crystal Violet, Chrysodine Y, Auramine O and Magenta. The wash fastness of bleached sulfonated jute fiber and bleached sulfonated jute-cotton blended fabric after dyeing had excellent impact than bleached raw jute fiber .The sulfite treatment of jute providing strong ionic interaction with the dye and reducing its tendency to be washed out on laundering. On the other hand, the light fastness of bleached sulfonated jute fiber and bleached sulfonated jute-cotton blended fabric was much better than that of bleached raw jute fiber. The sulfonation of jute protected photo-fading by chemically attached of sulfonic group in the phenolic hydroxyl groups of lignin. In all cases, dyeing fastness properties of bleached sulfonated jute-cotton blended fabric had almost same as bleached cotton fabric. The loss in breaking strength of dyed bleached sulfonated jute-cotton blended fabric was lower than that of dyed bleached sulfonated and raw jute, and higher with that of dyed bleached cotton fabrics. The color fastness properties of dyes are in the order of Magenta>Crystal Violet >ChrysodineY>AuramineO.

References

Basic Dyestuff (Shade Card Manual)(1951). ICI Ltd., Manchester, England, 13-18.

Carpmaels, W. (1924), Improvement in the Manufacture Lakes. British Patent No. 216486.

Carpmaels, W.(1928). The Manufacture of New Phospho-tungstomolybdenum Compound and the Manufacture of Lakes thereform. British Patent No. 292253.

Richards, K.M. (1936). Phospho-tungstic Lakes. Society of Dyer and Colorist, 52,378-380.

Harper, R.J., Bruno, J.S., Blanchard J. & Gautreaux, A. (1976).Simultaneous Dyeing and Crosslinking of Cellulosic Fabrics. U.S. Patent No. 3975152.

Roderich, R. (1984). Cationic Dyes. Rev. Prog. in Coloration. Society of Dyer and Colorist Publication, Bradford, England, 4, 187–205.

Trotman, E.R.(1984). Dyeing and Chemical Technology of Textile Fibers. Charles Griffin and Company Ltd., England (6th edn.), 285, 223–230.

"Nunn, D.M. (1979). The dyeing of Synthetic-Polymer and Acetate Fibers. Dyers Company Publication Trust. Bradford, England, 18-22."

Color Index, (1976). Society of Dyer and Colorist Publication, Bradford, England. Revised 3rd edn., 6, 6073–6101.

Patro, P.S. (1971). Dyeing of jute with basic, acid, direct and sulfur dyes. Textile Dyer and Printer, 4, 57-62.

Hossain, I., Hassanuzzaman, M. & Farouqui, F.I.(1989).Effect of metal salts on color fastness of dyed jute fiber. The Indian Textile Journal, 216-222.

Sayeed, M.A., Islam, N., Farouqui, F.I & Faruq, M.O. (1987). Dyeing of raw and bleached jute with Catechu Brown dye. The Rajshahi University Studies (Part B), 15, 1-17.

J T A T M

Hossain, I. and Farouqui, F.I (1990). A study on the optimum dyeing conditions in dyeing of jute with basic dyes and their fastness under various influences. Textile Dyer and Printer, 23, 28.

Hossain, I. & Farouqui, F.I.(1990). Mordant dyeing of jute. Textile Asia, 21, 69.

Janson, J. & Sjostron, E. (1966). Sulfur content in relation to the degree of sulfonation in Birch & Spruce sufite pulp. Journal of Svensk Paperstdin, 69, 107.

Ibrahim, H. M. (2002). Effect of hydrogen peroxide bleaching on sulphonated jute-cotton blended fabric. Indian Journal of fiber & Textile Research, 27, 280.

Salam, M.A, Farouqui, F.I & Hossain, I. (2002). Dyeing of bleached Sulfonated jute-cotton blended fabrics with mordant dyes. Indian Textile Journal, 6, 27.

AATCC Technical Manual (2000). Research Triangle Park, NC, 75.

Chatterjee, S.M.(1975). Reactivity of jute. Indian Textile Journal, 8, 149.

Callow & Speakman (1949).Study on the photochemical changes in jute fiber. Society of Dyer and Colorist, 65, 758.

Zollinger, H. (2003). Structure and Stereochemistry of the Transition States and Intermediates of Heterolytic Aromatic Substitutions. Journal of Angewandte Chemie, 11(10), 874.

Egerton, G.S. (1949). The mechanism of photo-chemical degradation of textile materials. Textile Research Journal, 764-65.

J
T
A
T
M