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Direct Dyeing of Jute: Effect of Cationic Treatments on Color Fastness

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Abstract

Direct dyes represent one of the cheapest and the simplest dyeing systems usually require only an electrolyte for their application. They are widely used in the textile industry because they are cheap and the only problem is their fastness properties that were solved in this research. Different techniques have been developed to enhance their fastness properties, one of them being the use of a cationic dye fixing agents. Bleached jute fabrics were dyed with direct dye before and after the treatment of cationizing agents and their properties are compared. It was found that in terms of fabric rubbing fastness, washing fastness and K/S value, cationization after dyeing is superior to cationization before dyeing.

Keywords: Jute; Cationizing agent; Direct dye; K/S value; Rubbing fastness; Washing fastness

Introduction

Jute fiber consists of strands i.e., bast bundle fiber assemble in parallel manner with overlapping to produce filaments throughout the length of the stalk. It is physically coarse, meshy, harsh, and irregular in length and diameter. Jute contains bundle of fibers which are joined together with natural cementing materials as lignin and hemi-cellulose [1]. The eco-friendly and bio-degradable nature of jute fiber along with its tenacity and long staple length has made this fiber popular in the field of textile and other decorative end uses products (Table 1) [2].

Direct dyes are sodium salt of sulphonic acid and most of them contain an azo group as the main chromophore. Direct dye is a class of dyestuffs that are applied directly to the substrate in a neutral or alkaline bath. Direct dyes give bright shades but exhibit poor wash-fastness. Various after-treatments are used to improve the wash-fastness of direct dyes, and such dyes are referred to as "After-treated Direct Colors". Direct dyes are molecules that adhere to the fabric molecules without help from other chemicals. Direct dyes are defined as anionic dyes with substantivity for cellulosic fibres, normally applied from an aqueous dyebath containing an electrolyte, either sodium chloride (NaCl) or sodium sulfate (Na_2SO_4) [3]. During dyeing process, about 20% dye hydrolyzed with water and drained out with water which is not eco-friendly [4]. Direct dyes thus pollute the environment by discharging highly colored species and higher electrolyte concentration. Higher electrolyte concentrations in effluents cause worse effects such as impairing the delicate biochemistry of aquatic organisms, destructive attack on concrete pipes is sodiumsulphate is used as electrolyte due to the formation of alumino-sulphato complexes which swell and crack concrete with considerable alumina content. Evolution of hydrogen sulphide gas under anaerobic conditions when sodium sulphate is used as electrolyte. Dissolution of such sulphide and subsequent bacterial oxidation to harmful sulphuric acid [5]. To overcome these problems and improve the dye ability of fabric the surface modification of fabric is done. This can be done by treating the fabric with strong cationic reactive agent which react with hydroxyl groups of fabric and produce positive charge on the surface of the fabric. By introducing cationic group, the fabric become cantonized and has columbic attraction between cationic fabric surface and anionic dyestuff. This cantonized fabric can be dyed without the use of electrolyte (Table 2) [6].

Cationization is the chemical modification of cellulose to produce cationic (positively charged) dyeing sites in place of existing hydroxyl (-OH) sites at which negatively charged dye can attach. Dyeing cationic-treated fabric results in greater use of dye and higher color values (Table 3). In addition, the strong dye-fiber interactions resulting from cationizing allow dyeing with no added electrolytes and minimal rinsing and after washing. Cationized fabric shows increase in the uptake of direct dyes, acid dyes and reactive dyes [7].

S. No.	Types of cationizing agents	Dye (%)	Concentration (%)
1	Ultrafix WS Conc.	3	1
2	Ultrafix WS Conc.	3	2
3	Cyclanon fast HWF	3	1
4	Cyclanon fast HWF	3	2
5	(3-chloro-2-hydroxypropyl) trimethyl ammonium chloride	3	1
6	(3-chloro-2-hydroxypropyl) trimethyl ammonium chloride	3	2
7	Simple dye	3	

Table 1: Application of cationizing agent after dyeing.

S. No.	Types of cationizing agents	Concentration (%)	Dye (%)
1	Ultrafix WS Conc.	1	3
2	Ultrafix WS Conc.	2	3
3	Cyclanon fast HWF	1	3
4	Cyclanon fast HWF	2	3
5	(3-chloro-2-hydroxypropyl) trimethyl ammonium chloride	1	3
6	(3-chloro-2-hydroxypropyl) trimethyl ammonium chloride	2	3

Table 2: Application of cationizing agent before dyeing.

Direct dye (RED)	Concentration (%)	Washing fastness	K/S value	Rubbing fastness	
				Dry	Wet
Simple dye	3	01-Feb	20.56	03-Apr	2

Table 3: Properties of controlled sample.

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The literature review exposed that a lot of study has been done on the dyeing of jute. Jute is mostly dyed with natural and reactive dyes. These dyes give good fastness properties and these dyes are costly so the dyeing process become costly, but dyed jute is mostly used in packing, fashion and apparel industry where fastness is not a priority. So it is imperative that we dye the jute with that type of dyes that are not costly and their fastness properties are good [1,2,8-14]. In the present work, an attempt was made to dye the jute fabric with direct dye and check the effect of different cationizing agents on fastness properties (Table 4).

Materials and Methods

Substrate

Grey jute fabric was taken from Nishat Textile Bikhi.

Chemicals

The following chemicals of analytical grade were used in the experiment: hydrogen peroxide, sodium hydroxide, wetting agent, sequestering agent, stabilizer, salt and acetic acid.

Cationizing agent

Three cationizing agents were used.

I. Ultrafix WS Conc.

II. Cyclanon fast HWF

III. (3-Chloro-2-hydroxypropyl) trimethyl ammonium chloride.

Methods

Bleaching

Bleaching was done on lab-scale jigger machine at 95°C for 45 minutes by using 40 g/L hydrogen peroxide, 24 g/L caustic soda, 4 g/L wetting agent, 4 g/L sequestering agent and 14 g/L stabilizer followed by rinsing with tap water.

Cationizing treatment

Three types of cationizing agents with two concentrations of each were used. On six samples, cationizing agents were applied before dyeing and six samples were cationized after dyeing.

Dyeing

Jute was dyed by using red direct dye. Seven samples were dyed by using 1 g/L dye, 2 g/L alkali, 1 g/L salt, 2 g/L wetting agent and 2 g/L sequestering agent. Six samples on which cationizing agent was applied before dyeing, were dyed without alkali and salt.

Experimental Design

Testing

Dry and wet rubbing fastness values of the dyed samples were evaluated according to AATCC TM-08. Washing fastness values of dyes samples were evaluated according to AATCC test method 61-2010. K/S values of dyed samples were evaluated according to the AATCC 6-2008 (Table 5).

Results and Discussion

Rubbing fastness

A comparison of rubbing fastness of cationizing agent apply before dying and after dyeing shows in Figure 1. It can be noticed that both dry and wet rubbing fastness of cationizing agent apply before dyeing are poor in comparison to cationizing agent apply after dyeing.

Washing fastness

A comparison of washing fastness of cationizing agent apply before dying and after dyeing shows in Figure 2. It can be noticed that washing fastness of cationizing agent apply before dyeing is poor in comparison to cationizing agent apply after dyeing.

K/S value

A comparison of K/S value of cationizing agent apply before dying and after dyeing. It can be noticed that K/S Value of cationizing agent apply before dyeing is poor in comparison to cationizing agent apply after dyeing.

Conclusion

It is concluded from above research that application of cationization agent after dyeing give better results as compared to application

Cationizing agent	Concentration (%)	Washing fastness	K/S value	Rubbing fastness	
				Dry	Wet
Ultrafix WS	1	03-Apr	23.76	4	03-Apr
Ultrafix WS	2	03-Apr	30.68	4	3
Cyclanon Fast HWF	1	03-Apr	18.24	03-Apr	01-Feb
Cyclanon Fast HWF	2	03-Apr	19.85	03-Apr	01-Feb
CHTAC	1	03-Apr	7.02	4	03-Apr
CHTAC	2	03-Apr	18.78	4	03-Apr

Table 4: Properties of samples treated with cationizing agent after dying.

Cationizing agent	Concentration (%)	Washing fastness	K/S value	Rubbing fastness	
				Dry	Wet
Ultrafix WS	1	3	12.32	4	3
Ultrafix WS	2	3-4	9.11	3-4	1-2
Cyclanon Fast HWF	1	3	11.91	3-4	1-2
Cyclanon Fast HWF	2	1-2	7.99	4	3
CHTAC	1	1-2	15.85	3-4	1-2
CHTAC	2	1-2	7.56	4	3

Table 5: Properties of samples treated with cationizing agent before dying.

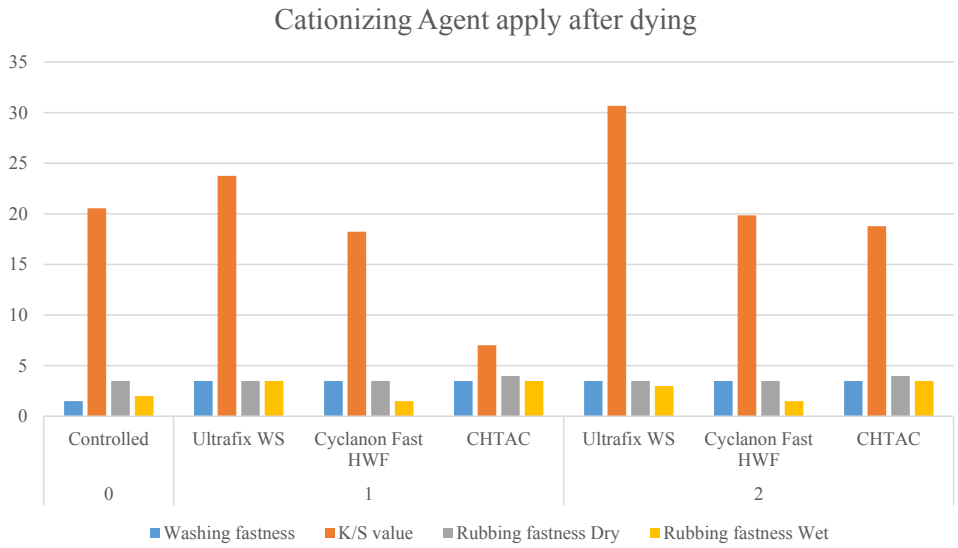

Figure 1: Graphical comparison of samples treated with cationizing agent after dying.

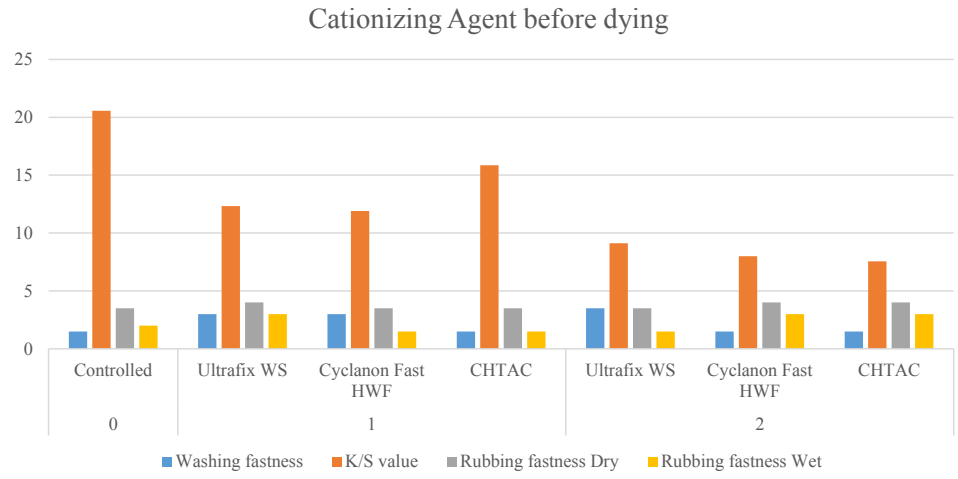

Figure 2: Graphical comparison of samples treated with cationizing agent before dying.

before dyeing. The use of cationizing agent increase the dye fixation by chemical reaction of positively charged substrate and negatively charged dye molecule. This method of dyeing is ecofriendly causes it is free of salt and percentage of dye in effluent is reduced.

Future Work

- Development of such cationic fixer which is cheapest easily available in market.
- Development of such cationic fixer which easily attached with fabric and strongly bonded.
- Development of such cationic fixer which effective at less concentration.
- To measure the effluent of the dye bath of both cationized and un-cationized jute using different cationizing agents.

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