Indian Journal of Fibre & Textile Research
Vol. 40, June 2015, pp. 157-161

Properties of jute-cotton union fabrics through wet processing treatments: Part II−Double cloth structures with jute weft in subdued form

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Received 3 April 2014; revised received and accepted 16 May 2014

In this study, self stitched double cloth and weft wadded self stitched double cloth woven fabrics with cotton warp and jute weft have been prepared in such a way that the appearance of jute weft is subdued on fabric surface. These fabrics are subjected to four kinds of wet processing treatments to suppress harshness and prickliness of jute component and to enhance fabric properties. Improvement in fabric properties has been determined through objective evaluation. Fabric handle of jute-cotton union double cloth fabric is improved by all the four treatments. Bending length is reduced for a particular weave with particular treatments only. Fabric tensile strength is reduced by all the four treatments.

Keywords: Fabric handle, Fabric harshness, Jute-cotton union fabric, Prickliness, Wet processing

1 Introduction

Jute is facing stiff competition from light weight synthetic products with regard to its traditional use in fabrics for packing purpose. Harshness, coarseness and prickliness of jute restrict its application areas. As a part of seeking diversified uses of jute, efforts have been made to develop fabrics using jute blended yarns. The developed fabrics are subjected to wet processing treatments. The main purpose of the study is to develop fabrics with jute constituent without harshness and prickliness associated with jute.

There is considerable reduction in protruding surface hairs and harshness of pure jute fabrics due to Biosoft-P(cellulase) enzyme treatment as reported in the literature[1,2]. A two-stage ecofriendly bleaching of jute with peracetic acid-hydrogen peroxide, as substitute for the conventional sodium hypochlorite – hydrogen peroxide bleaching, reported higher whiteness, lower strength loss and abrasion resistance, and improved softness compared to the conventional process. However, the problem of photo yellowing of the fabric for long duration photo exposure persisted[3]. When woven fabrics with cotton warp and jute weft are subjected to various wet treatments viz. acid steeping, sodium hypochlorite treatments, hydrogen peroxide bleaching and sodium hydroxide treatment, the highest weight loss is observed with sodium hypochlorite after acid steeping and greater percentage shrinkage is observed in warp direction compared to that in weft direction[4]. While assessing handle of various jute blended suiting fabrics using Kawabata system, it was found that all fabric samples were inferior with regard to their tailorability as compared to the standards laid downs for high quality fabrics and most of the jute blended fabrics did not satisfy fabric handle characteristics unless treated with proper finishing agent to improve fabric handle[5].

In our earlier paper[6], we have reported about enhancement of physical properties of jute-cotton union fabrics through wet processing treatments for simple woven structures with jute weft in subdued form. In this study, jute-cotton union fabric was prepared using cotton yarn as warp and jute yarn as weft. Weave and thread densities were so chosen to have subdued appearance of jute weft and dominant appearance of cotton warp on both sides of the fabric. These jute-cotton union fabrics were subjected to various wet processing treatments mainly to improve their handle which was judged from their physical properties.

2 Materials and Methods

2.1 Materials

2/10 Ne cotton warp yarn and 7 lbs jute weft yarn were selected for the study.

Soda ash, hydrogen peroxide, sodium meta silicate, peracetic acid, sodium hydroxide flakes, and dilute

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acetic acid (all of LR grade, supplied by Suvidhinath laboratories, Vadodara, India); polymeric quaternised softener (lush feel), amino acrylate liquid polymer (Zycrolate, Zydex industries, Vadodara, India); and acid cellulase enzyme (Palkostone, Maps Enzymes limited, India) were used.

2.2 Methods

2.2.1 Weaving

From cotton cones acquired from the market, weaver's beams were produced through warp preparatory processes of winding on PS-Mettler winding machine followed by sectional warping on P. Schweizer, Maschinebau sectional warping machine. Jute yarn was wound on pirns on Hatex pirn winding machine. Jute-cotton union fabrics were woven on a 36" power loom with dobby as well as drop box attachment of make Textile Cooper.

Samples were woven with 76 cm width in reed using 36's reed count, 3 ends/ dent. Picks/ cm for self stitched double cloth and weft wadded self stitched double cloth weaves were 28 and 34 respectively. Dominant appearance of cotton warp and subdued appearance of jute weft on both sides of the fabric is achieved due to closer spacing of warp threads as compared to weft threads.

2.2.2 Wet Processing

The fabric was first scoured on jigger with 4% (owf) soda ash at 80°C, maintaining material-to-liquor ratio at 1:30. After scouring the samples were divided into four parts. One of the parts was bleached with hydrogen peroxide followed by peracetic acid (termed as sequential bleaching in this study). Another part was subjected to woolenisation. Among the remaining two parts, one was finished with softener and the other one was treated with cellulase enzyme followed by finishing with softener. The detailed treatment conditions are given hereunder.

The sequential bleaching was performed using the following conditions: hydrogen peroxide 5% (owf), sodium meta silicate 7% (owf), material-to-liquor ratio 1:40, equipment jigger, *p*H 11, temperature 80-85°C, and time 2 h.

The peracetic acid bleaching was performed using the following conditions: peracetic acid (5%) 20 g/L, *p*H 6.5, material-to-liquor ratio 1:40, equipment Jigger, temperature 70° C, and time 1 h.

Woollenisation of the jute component in the jute/cotton union fabric was carried out using 16% (w/v) sodium hydroxide at room temperature for 45min, maintaining material- to- liquor ratio at 1:50 on Jigger. After woolenisation the samples were thoroughly washed and neutralized with dilute acetic acid.

The fabric samples were subjected to softening treatment using polymeric softener (lash feel) at 60°C for 45 min, keeping material- to- liquor ratio at 1:50 on Jigger. The fabric sample was first treated with cellulase enzyme followed by the treatment with polymeric softener.

A cellulase enzyme treatment was given to the fabric sample using 10% acid cellulase enzymes at 50° C for 60 min at *p*H 5, maintaining material- to-liquor ratio at 1:60.

2.2.3 Testing and Evaluation of Fabric

All the tests were performed for a population of 15 samples. The values presented in the tables are an average of nearer values of the findings. Drape coefficient of the fabric samples was measured as per IS: 8357-1977 method using drape meter [Presto-precision Standard Testing Equipment Corporation] with a circular test specimen of diameter 25 cm. An average of both sides (face and back) was taken for each sample.

Stiffness of the fabric samples in warp as well as weft direction was determined using cantilever test method as per ASTM D 1388-96 method with a specimen size of 25 cm × 2.5 cm.

The tensile strength of the samples in warp as well as weft direction was measured as per the ASTM D 5034 method using CRE Paramount digi-strength tensile testing equipment. Test samples of 6" × 3" were used and the traverse speed was 375 mm/min. An average of 5 observations was taken for each sample.

The tearing strength of the samples in warp as well as weft direction was measured as per the IS 6489-1993 method using Rosary lab tech instrument working on pendulum lever principle.

Fabric thickness of the samples was measured as per the IS 7702-1975 method using a precision thickness gauge with a flat anvil and a circular pressure foot. Averages of ends/cm and picks/cm were determined as per IS 1963-1981 method using a pick glass.

GSM of the fabric samples was determined as per IS 1964-2001 method for which circular sample of diameter 11.3 cm was cut using Paramount round cutter and then weighed to calculate GSM.

To determine relative proportion of jute weft and cotton warp by weight at grey stage, a square grey sample of 100 cm^2 was weighed. The ends and picks of the sample were unravelled carefully and weighed from which proportion of cotton warp and jute weft at grey stage was evaluated.

3 Results and Discussion

For each weave with its warp sett, maximum possible picks per cm on loom were accommodated. Warp and weft fractional covers, fabric thickness and jute content % depend on weave. Self stitched double cloth has 45% jute and 55% cotton, while weft wadded self stitched double cloth has 47% jute and 53% cotton.

3.1 Effect of Sequential Bleaching on Properties of Jute-Cotton Union Fabrics

Table 1 shows the effect of sequential bleaching on bending length. It is found that weft way bending length of the jute-cotton union fabric reduced after sequential bleaching. On the contrary, the warp way bending length is found to be increased. Perhaps, this is due to two phenomena, namely (i) reduction in stiffness due to partial removal of hemi-cellulose after bleaching and (ii) introduction of some stiffness due to shrinkage of the fabric. The result shows that first factor predominated over the second in case of weft-wise measurement, while the reverse has happened in case of warp direction.

Drape coefficient is related to fabric feel and handle. Table 1 shows that after sequential bleaching there is a general trend of reduction in drape coefficient which indicates an improvement in fabric feel and handle. Drop in drape coefficient may be attributed to partial removal of hemicelluloses from the jute component during alkaline bleaching.

The table also shows the effect of sequential bleaching on warp and weft way tensile strength /gsm. It can be observed that there is appreciable reduction in weft way tensile strength/gsm on sequential bleaching for both the weaves. Warp way tensile strength decreases slightly on sequential bleaching treatment.

3.2 Effect of Woollenisation on Properties of Cotton-Jute Union Fabric

Cotton-jute union fabric was given woollenisation treatment. This treatment gives wool like crimp[2,7] to the jute. Table 2 shows that the fabric softness after woollenisation treatment is improved which is manifested as the drop in bending length. During woollenisation the woody hemicellulose part is partially removed which has brought an improvement in the feel of the fabric as indicated by the drop in bending length. There is a trend of increase in warp way bending length on woollenisation, which may be due to shrinkage (Table 2). Weft way bending length decreases on woollenisation.

Table 2 shows that the fabric softness is improved after woollenisation treatment which is manifested as

Table 1—Effect of sequential bleaching on physical properties of fabrics

Weave	Bending length, cm				% Drape coefficient		Tensile strength, kgf			
	Warp		Weft				Warp		Weft	
	Scoured	Bleaching	Scoured	Bleaching	Scoured	Bleaching	Scoured	Bleaching	Scoured	Bleaching
Self stitched double cloth	4.38	4.82	6.07	5.31	99.9	96.74	68.04	60.88	63.94	47.38
Weft wadded self stitched double cloth	4.65	5.07	6.06	5.57	95.19	92.69	65.12	60.3	71.82	50.8

Table 2—Effect of woollenisation on physical properties of fabrics

Weave	Bending length, cm				% drape coefficient		Tensile properties							
							Scoured				Woolenised			
	Warp		Weft		Scoured	Woollenised	Strength kgf		Extension mm		Strength kgf		Extension mm	
	Scoured	Bleaching	Scoured	Bleaching			Warp	Weft	Warp	Weft	Warp	Weft	Warp	Weft
Self stitched double cloth	4.38	4.56	6.07	5.64	99.9	92.31	68.04	63.94	25.58	10.02	63.3	55.7	22.7	13.44
Weft wadded self stitched double cloth	4.65	4.73	6.06	4.6	95.19	94.7	65.12	71.82	24.64	10.42	67.6	47.82	20.72	12.9

the drop in drape coefficient. The reduction in drape coefficient indicates an improvement in the drapability of the fabric. Both the weaves show decrease in drape coefficient of the fabric.

Table 2 shows the effect of woollenisation treatment on tensile properties. It can be observed that for both the weaves, there is reduction in tensile strength of jute weft. This may be attributed to the modification in chemical structure of jute due to partial removal of hemicellulose content in jute fibre. Extension of the jute weft at break increases after woollenisation due to introduction of crimp[1]. There is marginal change in warp way tensile strength.

3.3 Effect of Softening on the Properties of Cotton-Jute Union Fabric

Table 3 shows that the fabric softness after softening treatment is improved which is manifested as the drop in bending length. Softening treatment reduces intra and inter-fibre friction which makes fabric more pliable and hence bending length decreases. The reduction in bending length improves the bending property of the fabric. It is observed that warp way bending length is increased to some extent with this treatment, which may be the effect of shrinkage. The fabric softness after treatment with softening agent is improved which is manifested in the drop in drape coefficient. The reduction in drape coefficient clearly shows an improvement in the drape property of the fabric.

From Table 3 it is observed that weft way tensile strength reduces after softening treatment for both the weaves. This may be attributed to the slippage caused due to reduction in intra and inter fibre friction during tensile loading. It is seen that warp way tensile strength increases slightly on sequential bleaching treatment, which may be due to shrinkage effect.

3.4 Effect of Enzyme Treatment followed by Softening on the Properties of Cotton-Jute Union Fabric

Cotton-jute union fabric was given enzymatic treatment followed by softening, in which acid cellulase enzyme treatment was followed by amino acrylate liquid polymer softener application. Enzyme treatment removes surface cellulosic fibres from jute and softening treatment reduces intra and inter-fibre friction.

Table 4 shows that the fabric softness after enzyme treatment followed by softening for both the weaves is improved in weft direction, whereas it seems that shrinkage nullifies this effect in warp direction.

It can be observed that after enzyme followed by softening treatment, drape coefficient drops for both the weaves which shows an improvement in the fabric softness as measured by bending length. This improvement can be attributed to the reduction in surface hairs of jute fibres due to enzyme treatment and lubricating effect of softener.

Table 4 shows effect of enzymes followed by softening on tensile strength. It can be observed that there is drop in warp way as well as weft way tensile strength for both the weaves. This drop may be due to

Table 3—Effect of softening on physical properties of fabrics

Weave	Bending length, cm				% Drape coefficient		Tensile strength, kgf			
	Warp		Weft		Scoured	Softening	Warp		Weft	
	Scoured	Softening	Scoured	Softening			Scoured	Softening	Scoured	Softening
Self stitched double cloth	4.38	4.81	6.07	5.36	99.9	96.49	68.04	65.32	63.94	50.66
Weft wadded self stitched double cloth	4.65	5.05	6.06	4.6	95.19	91.96	65.12	66.5	71.82	46.46

Table 4—Effect of enzymes followed by softening on physical properties of fabrics properties

Weave	Bending length, cm				% Drape coefficient		Tensile strength, kgf			
	Warp		Weft				Warp		Weft	
	Scoured	Enzymes + softening	Scoured	Enzymes + softening	Scoured	Enzymes + softening	Scoured	Enzymes + softening	Scoured	Enzymes + softening
Self stitched double cloth	4.38	4.66	6.07	5.73	99.9	92.06	68.04	65.96	63.94	65.96
Weft wadded self stitched double cloth	4.65	4.67	6.06	5.42	95.19	91.86	65.12	60.82	71.82	60.82

the reduction in surface cellulosic fibres caused by enzyme treatment as well as slippage due to lubricating effect of softener.

4 Conclusion

4.1 Fabric handle of jute-cotton union double cloth fabric is improved by all the four treatments as reflected through reduction in drape coefficient.

4.2 Reduction in bending length on wet treatment reflects improvement in fabric handle. Each treatment is not found to reduce bending length. Bending length is reduced for a particular weave with particular treatments only. Fabric shrinkage on wet treatment also seems to be influencing the bending length.

4.3 Fabric tensile strength is reduced by all the four treatments which indicate influence of wet treatment on fabric. Reduction in tensile strength may be due to partial removal of hemicelluose from jute component or reduction in inter-fibre / inter-yarn friction (in case of softening treatment).

Acknowledgement

Authors are highly thankful to Mr. Sushil K Hada of Textile Research Application Development Centre, a unit of Birla Cellulose located at Kharach, Gujarat, India for providing all the help required to carry out the project.

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