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Performance of Jute Cotton and Viscose Blended Woven Fabrics Compared to Hundred Percent Cotton Woven Fabrics: Regarding Mechanical and Comfort Properties.

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A B S T R A C T

Jute is our golden fibre. Jute was confined in manufacturing only traditional ropes, hessian, sacking and carpet backing cloth (CBC) etc. Jute sector is facing tremendous challenges due to industrial revolution and cheap synthetic materials. To sustain jute in competitive market, it is inevitable to diversify and value addition in jute and jute goods. Blended yarn from jute-cotton-viscose fibre may be one of the important diversifications of jute. Viscose is a regenerated man-made cellulosic fibre. It is also called artificial silk. The purpose of this work is to innovate jute cotton viscose blended fabrics so as to substitute hundred percent cotton cloth. Therefore, mechanical and comfort properties (hand feel and softness) a of jute cotton and viscose blended fabrics have been contrasted with hundred percent cotton fabrics to attain the same or even superior final qualities. Hence, this experiment was undertaken. Here, hundred percent cotton plain woven and blended fabrics (30:40:30 ratio jute cotton and viscose blend yarn) were prepared to evaluate the blended raw fabric with hundred percent cotton fabrics. The mechanical properties (warp-wise and weft-wise tensile and tear strengths, stiffness), rubbing fastness, cover factor, drape coefficient and the comfort properties including air permeability were evaluated. It is found that jute cotton and viscose blended raw fabric shows better, or approximately close results compared to hundred percent cotton fabric. It follows that blended fabrics made of jute cotton and viscose can be used in place of fabrics made entirely of cotton.

Keywords: Jute, cotton, Viscose, Blending, weaving and Plain fabric.

1. Introduction

Now a days, blended fabric is getting popular over the world due to its special attributes like resolute dimensional stability, cost effectiveness, softness, luster, drape properties, wash fastness, dye ability, and many other properties of the fabric products.[1] Discovered in 1891, viscose was first produced commercially by Courtaulds in 1905 as a less expensive substitute for genuine silk. It is manufactured from wood pulp, typically from pine and spruce trees, or cotton linters. The wood cellulose goes through several processes leading to manufacture viscose fibre. Due to its abundance, cheap manufacturing costs, low density, long individual fiber length, and appropriate mechanical qualities, jute is the most appealing substitute among various natural plant fibers [2, 3]. Jute is the second most produced natural fiber after cotton (3.6 million tons). Jute is a bast fibre and cotton is seed fibre are familiar to us [4]. Hence the techniques of softening and blending could as utilize to increase the quality of jute and can form a new class of jute-based fabrics which may have an expanding market within and outside the country [5]. At first, jute was limited to only its conventional uses like ropes, sacking, hessian and CBC which are declining day by day due to inroads of cheap synthetic materials. Nowadays, in the era of industrial revolution, people are concerned about environment. As jute is environment friendly fibre, popularity of jute diversification is increasing over synthetic. Combining jute with different textile fibers is a highly valuable kind of diversification. As, both of viscose and cotton are costly and almost 100% imported fibre. The daily import of viscose fiber is rising. For example, import of viscose from 2018 to 2020 in Bangladesh was 40278 tons, 53289 tons (32.30% rise) and 53474 tons (june-sep.) appropriately. No fiber is hundred percent pure. Every fiber has excellent, far, and poor traits. Blending is the process of combining fibers to maximize the good qualities and reduce the bad. Additionally, blending reduces costs in the fabric manufacturing process [6]. 30/70 jute viscose/polyester union fabric is superior to other ratios, according to Shikha Bhardwaj and Shalini Juneja [7], and it also lowers the product's cost. Blending of jute and viscose is accomplished mainly with the idea of imparting the color, luster, and softness of rayon to jute yarns, increasing weaving efficiency, and reducing imperfections in jute products [8]. CR Debnath et al.,[9] also experimented on jute-Viscose Blending: Some Optimum Conditions in jute spinning system. Here, Jute was incorporated with cotton and viscose fibre and jute-cotton-viscose blended yarn was produced in rotor spinning frame [10,11]. The ratio of jute, cotton and viscose was 30:40:30. Here, Jute-cotton-viscose grey fabric was produced by rapier loom of jute-textile wing by the weft yarn which is blended yarn and warp yarn is 100% cotton yarn [12,13]. The fabric design was one up one down plain weave. 100% cotton grey fabric is also made from rapier loom with same design. In the present work, some properties of 100% cotton grey fabric and Jute-cotton-viscose grey fabric have been analysed. Here, characteristics of jute-cotton–viscose blended fabric would be evaluated and compared with 100% cotton fabric.

Utilizing textiles manufactured from blended yarns of jute, cotton, and viscose would undoubtedly boost our economy by reducing the expense of importing cotton and viscose and increasing value addition because locally produced, less expensive jute is used as a raw material [14,15,16].

2. Material and Methods

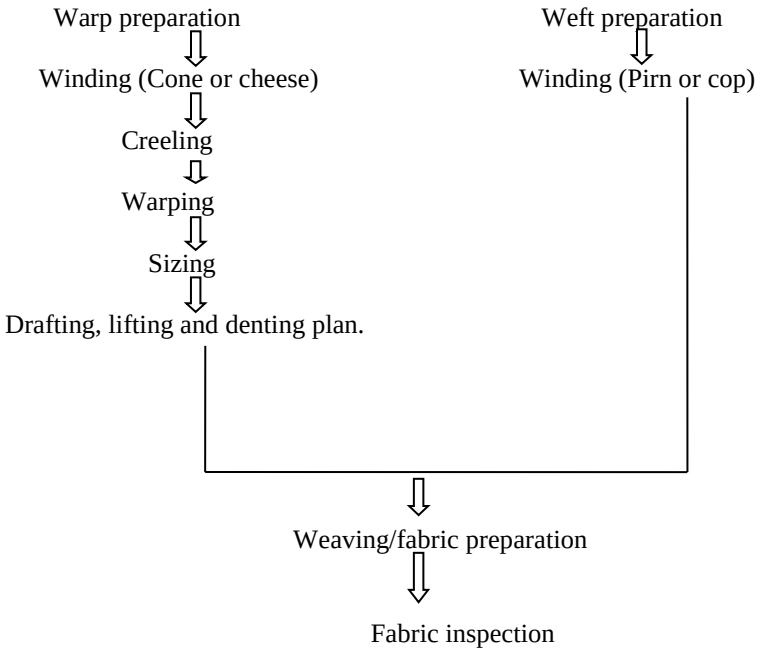
2.1 Preparation of fabrics

One of the experimented samples is hundred percent plain (1:1) cotton fabric which contains 50 average EPI, and 35 average PPI and average count of weft yarn is 5.89 Ne [17] and GSM is 232. Another sample is jute-Cotton-viscose Blended plain woven (1:1) fabric, which Contains 48 average EPI and 35 average PPI, and also average count of weft yarn is 6 Ne and GSM is 235. Above the two fabrics, the warp yarn is fixed with same count.

2.2 Weaving

Blended fabrics is making in this stage, it could be used for home textile. The innovative fabric is one up one down plain fabric.

2.3 Flow chart of fabric preparation in rapier loom



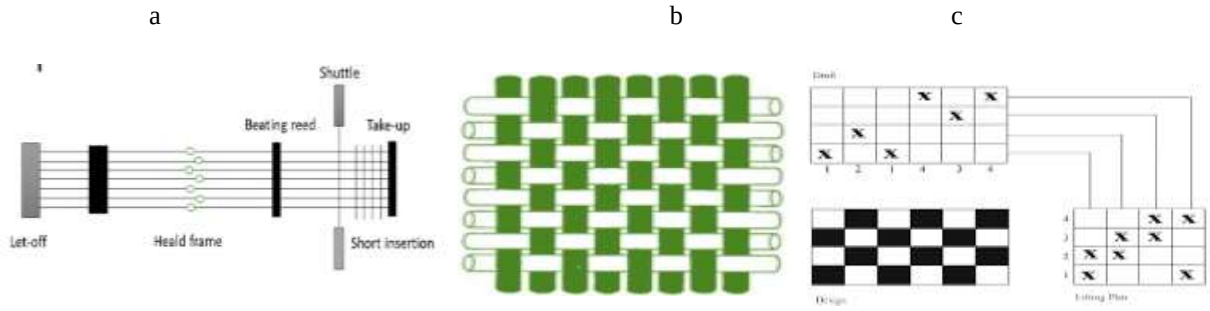


Figure 1. Woven fabric (a) Plain weaving architecture, (b) Weave plan, drafting and lifting plan, (c) Weaving machanism of rapier loom.

2.4 Drape coefficient of fabric:

It denotes the fabric deformation by gravity when It is permitted to hang by itself. "The drape coefficient is the ratio of the difference between the area of the draped sample and supporting disk to the difference between the area of the specimen and the supporting disk"[18]. Drape coefficient = $(A_s - A_d)/(A_D - A_d)$ (1)

Where, A_D = the area of the specimen,

A_d= the area of supporting disk, and

A_s = the actual projected area of the specimen.

Additionally, a percentage is used to express it. Higher the drape co-efficient, stiffer the fabric [19]. Its value becomes always less than one. Zeong & Philips [20,21] discovered that because fabric cover affects bending rigidity, it significantly affects fabric drape. The drape is additionally impacted by crimp and yarn interaction, both of which are governed by weave structure [22].

2.5 Cloth cover: The fabric cover can be defined as the structure of the fabric that shows the edge where the warp and weft threads are clearly sewn and obtained from the following equation [23],

Kc = K1 +K2 -K1 K2 /28 (2)

Where, Kc = Cloth cover

K1 = Warp cover factor

K2 = Weft cover factor

The term "warp cover factor" refers to the amount of space per inch of fabric that is covered by warp yarn, which was obtained as,

$K = \frac{Threads\ per\ inch}{\sqrt{Count}} = \frac{k}{\sqrt{Ne}}$ (3)

2.6 Air permeability:

It is a one of the comport properties of fabrics. The air permeability of fabric is the volume of air passed through unit area of the fabric per unit time. It is one of the comfort properties of fabric.

Tearing strength: It is defined (ASTM D1682) as the force required to start to tear a fabric, in either weft or warp direction, under specified conditions. Stiffness was measured according to ASTM D-4032 method [24].

2.7 Tensile strength of fabric:

Tensile strength of both fabric in warp and weft way was measured by universal tensile strength machine, Turkey. Strip test was done by ASTM D 5035 standard with sample size 150*100 mm.

3. Results and discussion

Table:1 Average EPI, PPI and GSM of 100% cotton grey fabric and Jute-cotton-viscose grey fabric.

100% cotton grey fabric	Sl. No.	EPI (Ends per inch)	Average EPI	PPI (picks per inch)	Average PPI	GSM	Average GSM
	1	48	50	36	35	234	232
	2	51		34		232	
	3	50		35		231	
	4	50		35		231	
	5	51		34		231	
Jute-cotton-viscose grey fabric	1	50	48	35	35	236	235
	2	47		36		233	
	3	48		34		240	
	4	49		35		233	
	5	48		34		234	

Table: 2 fabric cover factors of both 100% cotton and jute cotton viscose blended fabrics

100% cotton grey fabric	Sl. No.	Warp Cover Factor	Average Warp Cover Factor(k1)	Weft Cover Factor	Average Weft Cover Factor(k2)	Cloth Cover factor
	1	13.011	13.553	15.026	14.525	21.047
	2	13.824		14.191		
	3	13.553		14.608		
	4	13.553		14.608		
	5	13.824		14.191		
Jute-cotton-viscose grey fabric	1	13.292	12.866	13.717	13.639	20.237
	2	12.494		14.109		
	3	12.76		13.325		
	4	13.026		13.717		
	5	12.76		13.325		

Table: 3 Drape co-efficient, air permeability and tearing strength analysis of both fabrics.

100% cotton grey fabric	Sl. No.	Drape Co-efficient	Average Drape Co-efficient	Air permeability ($m^3/m^2/h$)	Average Air permeability ($m^3/m^2/h$)	Tearing strength(N)	Average tearing strength(N)
	1	0.74	0.73	2840.5	2830.10	32.23	32.12
	2	0.73		2795		31.10	
	3	0.73		2855		33.15	
	4	0.72		2840		32.05	
	5	0.73		2820		32	
Jute-cotton-viscose blended grey fabric	1	0.77	0.78	2855	2871	29.15	29.16
	2	0.78		2842		28.56	
	3	0.78		2855		29	
	4	0.79		2922.6		30.07	
	5	0.78		2880.4		29	

Table: 4 Rubbing fastness and stiffness of both fabrics.

100% cotton grey fabric	Sl. No.	Rubbing fastness		Stiffness (cN)	Average Stiffness (cN)
		Dry rubbing	Wet rubbing		
	1	5	5	135	135.6
	2	5	5	131	
	3	5	5	139	
	4	5	5	133	
	5	5	5	140	
Jute-cotton-viscose blended grey fabric	1	5	4	194	194
	2	5	4	185	
	3	5	5	182	
	4	5	4	205	
	5	5	4	204	

Table 5: Fabric strength test of both fabrics by Universal Strength Testing machine

100% cotton grey fabric	Sl. No.	Maximum stength in warp wise(N)	Mean	CV (%)	Maximum force in weft wise(N)	Mean	CV (%)
	1	498	507	6.07	922	882	5.06
	2	503			880		
	3	527			807		
	4	545			894		
	5	464			907		
Jute-cotton-viscose blended grey fabric	1	579	560	6.94	581	527	7.68
	2	560			572		
	3	565			461		
	4	496			534		
	5	600			538		

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From table 1, the average EPI of hundred percent cotton grey fabric is found 50 and the average EPI of jute cotton viscose grey fabric 48. Although, there is some difference in EPI but the average PPI of both hundred percent cotton grey fabric and jute cotton viscose are same such as 35. So, it is proved that approximately the same count is weft direction. Higher the cover factor is higher the compactness of fabric. The cover factor of hundred percent cotton grey fabric (21.047) is more than the jute, cotton, and viscose blended grey fabric (20.237). Hence, hundred percent cotton grey fabric is more compact than jute, cotton, and viscose blended grey fabric [25,26]. The fabric has good draping or hanging qualities when the drape coefficient is low. The average drape coefficient of jute-cotton-viscose blended grey fabric (0.78) is very closer to 100% cotton grey fabric (0.73). So, the blended fabric could be used as not only alternative to hundred percent cotton fabric but also curtain fabric. The average value of air permeability of jute-cotton-viscose blended fabric is 2871 $m^3/m^2/h$ which is better than hundred percent cotton grey fabric 2830.10 $m^3/m^2/h$. The tearing force of jute-cotton-viscose blended fabric (29.16 N) is closer to hundred percent cotton fabric (32.12N) which is a good aspect of fabric. From table 1, there is no difference between dry rubbing between jute-cotton-viscose fabric and hundred percent cotton grey fabric, but wet rubbing is slightly changed (4/5) in case of jute-cotton-viscose fabric. The average stiffness of jute-cotton–viscose fabric (194cN) is higher than the hundred percent cotton fabric (135.6cN). So, the softness jute-cotton-viscose fabric is near to the hundred percent cotton fabric. The average value of tensile strength in warp direction between hundred percent cotton grey fabric and jute-cotton-viscose blended grey fabric are 507N and 560N respectively which is very excellent and closer. The developed blended fabric demonstrated higher strength compared to 100% cotton grey fabric. The CV (%) of tensile strength in warp direction of both fabrics are 6.07 and 6.94 respectively. Although, the average value of tensile strength of jute-cotton-viscose blended grey fabric (882N) in weft direction is more than hundred percent cotton grey fabric (527N), the CV (%) of both yarn are 5.06 and 7.68 respectively.

4. Conclusion

Jute-cotton-viscose blended yarn is prepared by the simple procedure of blending from 30%, 40%, and 30% ratios of jute cotton and viscose, with open end spinning and hundred percent cotton yarn is also prepared with same process. The plain woven (1/1) fabrics from both yarns were made from rapier loom. We have noticed that the properties of jute-cotton-viscose blended yarn approximate same or even better result than hundred percent cotton fabric. For instance, the drape property, tensile strength in weft way, and cloth cover factor are close to its counterpart. But the tensile strength in warp way is better than hundred percent cotton fabric. The CV (%) of the parameter are almost same between both fabrics. Jute-cotton-viscose blended fabric (2871 $m^3/m^2/h$) would be as comfortable as hundred percent cotton fabric due to lower air permeability (2830.10 $m^3/m^2/h$) and suitable for winter season. The only limitation of jute-cotton-viscose blended fabric is such as higher average stiffness value than hundred percent cotton fabric due to incorporation of jute fibre in yarn which could be overcome in next process. After all, this developed jute-cotton-viscose fabric could be used as replacement to hundred percent cotton fabric**.**

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