Available online at www.ijpab.com

DOI: http://dx.doi.org/10.18782/2320-7051.6713

ISSN: 2320 – 7051

Int. J. Pure App. Biosci. **6 (3):** 453-459 (2018)

Research Article

International Journal of Pure & Applied Bioscience

OPEN ACCESS

Mechanical Properties of Cotton × Bamboo and Tencel Union Fabrics

Renuka Medar[1*] and Geeta Mahale[2]

Ph.D Scholar[1] and Professor[2],

Department of Textile and Apparel Designing, College of Community Science, UAS Dharwad

*Corresponding Author E-mail: rain23medar@gmail.com

Received: 18.05.2018 | Revised: 24.06.2018 | Accepted: 29.06.2018

ABSTRACT

Clothing is an essential need of human beings in day to day life. It is the most fundamental requirement necessary to survive. Clothes can either be produced from natural fibres such as cotton, wool, silk, hemp and linen or from manmade fibres such as rayon, nylon. A study was conducted to assess the mechanical properties of cotton × bamboo/tencel union fabrics in the dharwad, Karnataka during the period 2016-2018. Five plain woven fabrics namely cotton × cotton, cotton × bamboo 20s, cotton ×bamboo 30s , cotton ×tencel 20s and cotton × tencel 30s were produced on a pit loom by a master weaver in Hubli. All the developed fabrics were assessed for mechanical properties viz., cloth count, cloth dimensional stability, cloth weight, cloth thickness, cloth stiffness and cloth crease recovery under standard testing method after conditioning the samples at standard atmospheric conditions. It was observed that. all the mechanical properties were found to be higher in union fabrics when compared to cotton × cotton fabric as addition of bamboo and tencel with cotton enhances the fabrics performance properties thus making it more stronger , durable and user- friendly.

Key words: *Cotton, Bamboo, Tencel, Union fabrics*

INTRODUCTION

Eco-friendly textile has entered not only to the shelves of textile shops but also to the largest retailers and brand dealers, thus making it a milestone for consumer recognition and a trustworthy quality assurance concept. Going "green" is the growing trend wherein textile industry is one of the most ecologically harmful industries in the world. Some harmful stages of textile industries are fiber growth with herbicides or pesticides, dyeing with toxic chemicals, emissions to air and water, toxicity potential of processing wastes and area usage of the textile drains. Textile contributions to diminish global warming are developing using ecofriendly fibres, textile processing techniques, non-toxic chemical usage of the textile unit, *etc*[2]. Wherein bamboo and tencel fibres are one of the eco-friendly fibres which are both user-friendly and eco-friendly. Woven fabrics can be can be studied under different sub headings namely mechanical, performance, durable and comfort properties. Mechanical properties enlighten fabric structure, fabric density which is a result of the interlacement of warp and weft yarns which are held under required tension and variation in the yarn linear densities.

Cite this article: Medar, R. and Mahale, G., Mechanical Properties of Cotton × Bamboo and Tencel Union Fabrics, *Int. J. Pure App. Biosci.* **6(3):** 453-459 (2018). doi: http://dx.doi.org/10.18782/2320-7051.6713

Thus aim of the paper was to study the structural properties of cotton × bamboo and tencel union fabrics.

MATERIAL AND METHODS

The study was conducted during the period 2016-2018 in Department of Textile and apparel designing, College of Community Science, UAS Dharwad. 2/20s cotton yarns were procured from KHDC Gadag, Karnataka while 100 per cent bamboo and tencel yarns of 20s and 30s were procured from Pallava textiles, cotton mill, Mangarangam palayam, Tamil Nadu.

Weaving bamboo and tencel union fabrics

Weaving is the method of fabric production wherein, two sets of yarns are interlaced at right angles to each other. Five types of plain woven union fabrics namely cotton × cotton (CC) [Control], cotton × bamboo 20s (CB_1), cotton × bamboo 30s (CB_2), cotton × tencel 20s (CT_1) and cotton × tencel 30s (CT_2) were produced on a pit loom at Malali Village, Karnataka wherein cotton yarns were used as warp and bamboo and tencel yarns of varying counts were used as weft. Developed fabrics were assessed for cloth dimensional stability, cloth count, cloth weight, cloth thickness, cloth stiffness and cloth crease recovery. Data analysis was done using two factorial analysis in WINDOSTAT Version. 9.0.

Fabric testing

Cloth dimensional stability is measured in terms of shrinkage percentage. The fabric sample of 25 cm × 25 cm was taken and initial length of 20 cm was marked both in warp and weft direction. The test samples were soaked in the soap solution of 2gpl at room temperature for one hour rinsed thoroughly in cold water and dried under shade. The dried samples were pressed gently without stretching. Further final lengths were measured and shrinkage percentage was calculated.

Cloth count in woven textile material is the number of ends and picks per unit area while the fabric is free from wrinkles and is affected by the yarn count and compactness of the weave. The number of warp and weft yarns in one square inch of the fabric is counted at five random selected places across the width and along the length of the test specimens. The region near the selvedge should be avoided because the spacing of thread is often a little different than in the body of the cloth[1].

Cloth weight is expressed as mass per unit area in g/sq.mt. A sample of 5 × 5 cm was cut and weighed on an electronic weighing balance to determine the weight per sq.mt (g) [1]. Further, warp and weft threads were separated and weighed to calculate respective percentages.

Thickness is the distance between the upper and lower surface of the material measured under a specified pressure, expressed in mm. The specimens were tested as directed in BS test method 2544:1954[1]. The specimen chosen were free from folds, crushing or distortion, wrinkles, specimen were placed on the anvil of test apparatus and bring the pressure foot into the contact with the opposite side of the material and record the thickness in mm, the shape of the anvil and pressure foot was round. The thickness gauge instrument was used for measuring thickness. Five readings were recorded and mean was calculated.

Fabric stiffness is the resistance of the fabric to bending. Bending length is the length of the fabric that bends under its own weight to a definite extent. The test samples were tested as directed in BS test method: 3356-1961. A rectangular strip of fabric, 6 inch × 1 inch was mounted on a horizontal platform in such a way that it hangs like a cantilever and bends downwards. Test specimen was cut with help of template and then both template and test specimen was placed on the platform with the fabric underneath. Both were pushed forward slowly. The strip of fabric was started to a droop over the edge of the platform and the movement of the templates and the fabric was continued until the tip of the specimen viewed in the mirror cuts both index lines. The bending length was read off from the scale mark opposite a zero line engraved on the side of the platform. Five readings were recorded by using Shirley's stiffness tester [1].

Crease recovery is nothing but allowance of the fabric to recover from the crease. The test samples were tested as directed in IS method: 4681-1968 by using Shirley's crease recovery tester. Samples were cut both warp and weft way from the fabric with a template, 2 inch long by 1 inch wide. It was creased by folding into half and placed under a weight of 2 kg for 5 minutes. The weight was removed and the specimen was transferred to the fabric clamp on the instrument using forceps and was allowed to recover from the crease for 5 minutes. As it recovered the dial of the instrument was rotated to keep the free edges of the specimen in line with the knife edge. At the end of the time period as it was allowed for recovery, usually 1 minute the recovery angle in degrees was read on the engraved scale. Readings were recorded for both warp and weft separately[1].

RESULTS AND DISCUSSIONS

A perusal of Table 1 explains general information about the constructional parameters of yarns and specific information of the fabrics. 2ply cotton yarn possessing Z twist was used as warp yarn while 2 ply bamboo and tencel (each 20s and 30s) possessing Z twist were used as weft yarn were used to weave a plain woven union fabrics in a handloom with 72'' reed width, cloth width of 36'' with 2 threads/dent denting order.

Table 1: Constructional details of cotton × bamboo/tencel union fabrics

Sl. No.	Union fabrics	Direction	Fiber Content	Yarn type	Twist Direction	Yarn count	Weave
1	Cotton × Cotton (CC)	Warp	Cotton	2 ply	Z	2/20s	Plain
		Weft	Cotton	2 ply	Z	2/20s	
2	Cotton × Bamboo (CB_1)	Warp	Cotton	2 ply	Z	2/20s	Plain
		Weft	Bamboo	2 ply	Z	20s	
3	Cotton × Bamboo (CB_2)	Warp	Cotton	2 ply	Z	2/20s	Plain
		Weft	Bamboo	2 ply	Z	30s	
4	Cotton × Tencel (CT_1)	Warp	Cotton	2 ply	Z	2/20s	Plain
		Weft	Tencel	2 ply	Z	20s	
5	Cotton × Tencel (CT_2)	Warp	Cotton	2 ply	Z	2/20s	Plain
		Weft	Tencel	2 ply	Z	30s	

Shrinkage is the percentage of compactness of the yarns in both warp and weft direction when exposed to water[3]. It is evident from Table 2 that among all the fabrics CC fabric exhibited the highest dimensional stability compared to the union fabrics in warp (69.70%) direction as cotton being cellulosic in nature has a tendency to shrink readily thus making the fabric more absorbent. Whereas, tencel union fabric possessed higher dimensional stability in warp way (69.40%) as crystalline region of tencel makes a fabric less absorbent and higher crysatllinity delays the water molecule to enter into the polymer system compared to CC fabric. The results of a study on utilization on naturally colour linted cotton yarns in the handloom sector to produce union fabrics by Sadhana[4] were on par with the present research.

On the contrary, CT_1 fabric possessed highest cloth dimensional stability in weft direction (78.80%) which may be due to the compactness of the weave and presence of slackly twisted tencel yarn in weft direction makes the water molecules to get penetrated on the fabric substrate easily. Statistical results showed that, significant difference was found among the fabrics (0.07*), warp and weft direction (0.04*) and the interaction between fabrics and warp and weft direction (0.11*) at 5 per cent level of significance.

Table 2: Cloth dimensional stability of cotton ×bamboo/tencel union fabrics

Sl. No.	Union fabrics	Cloth dimensional stability (%)		
		Initial length (cm)	Warp (cm)	Weft (cm)
1.	CC	20	17.94 (69.70)	19.70 (78.50)
2.	CB_1		17.84 (69.20)	19.28 (76.40)
3.	CB_2		17.28 (66.40)	19.28 (68.00)
4.	CT_1		17.60 (68.00)	19.08 (75.40)
5.	CT_2		17.88 (69.40)	19.76 (78.80)

Figures in parenthesis indicate percentage

ANOVA Table

Factors	S.Em. ±	C.D. (5 %)	C.V. (%)
A- (Union fabrics)	0.02	0.07*	0.46
B- (Warp and weft)	0.01	0.04*	
A × B- (Union fabrics) × (warp and weft)	0.03	0.11*	

*- Significant at 5 % level of significance; CD- Critical difference; CV- Coefficient of variation

Table 3 shows the cloth count of the union fabrics, it was found that, compared to the CC (48) fabric, union fabrics (50) attributed highest cloth count in warp direction on the contrary CT_2 (27,), CC and, CB $(26)_1$ and obtained highest cloth count in weft direction which is due to variation in the fibre content, type of yarn, yarn coarseness and fineness, weaving technique, compactness of the weave and type of loom on which the fabric was woven. Statistically significant difference was found at 5 per cent level of significance. With respect to fabrics (1.05*), warp and weft direction (0.66*) and interaction between fabrics with warp and weft way (1.49*) direction.

Table 3: Cloth count of cotton × bamboo/tencel union fabrics

Sl. No.	Union fabrics	Cloth count (Ne)	
		Warp	Weft
1.	CC	48	26
2.	CB_1	51	23
3.	CB_2	50	26
4.	CT_1	50	23
5.	CT_2	50	27

ANOVA Table

Factors	S.Em. ±	C.D. (5 %)	C.V. (%)
A- (Union fabrics)	0.368	1.05*	3.07
B- (Warp and weft)	0.233	0.66*	
A × B- (Union fabrics) × (warp and weft)	0.521	1.49*	

*- Significant at 5 % level of significance: CD- Critical difference; CV: Coefficient of variation

Cloth weight is the density of the cloth which aids in determining the thickness of the cloth which is expressed in grams per meter square. From Table 4 it was found that, total weight of the union fabrics CB_1,(174.9gm/m_2), CB_2(172.7 gm/m_2) and CT_2(172.2 gm/m_2) was higher when compared to CC (166.6 gm/m_2) fabric which may be attributed due to fibre content of bamboo and tencel, variation in yarn count and superficial accumulation of residual particles in the interstices of cloth during weaving process. Sadhana[4] stated that coarseness of the yarns adds weight to the resultant fabric thus leading to reduction in number of picks per inch. Statistical results interpreted that, significant difference was obtained among the union fabrics (0.66*), product of total weight with warp and weft direction (0.43*) and also between the fabrics and total weight with warp and weft direction (0.96*) at 5 per cent level of significance.

Table 4: Cloth weight of cotton × bamboo/tencel union fabrics

Sl. No.	Union fabrics	Cloth weight (gm/m^2)		
		Total weight	Warp	Weft
1.	CC	166.6	120.8 (72.4)	42.0 (25.1)
2.	CB_1	174.9	130.5 (74.6)	44.24 (25.2)
3.	CB_2	172.7	123.6 (71.5)	48.0 (27.7)
4.	CT_1	169.2	115.0 (67.9)	45.44 (26.8)
5.	CT_2	172.2	121.2 (70.3)	49.12 (28.5)

Figures in parenthesis indicate percentage

ANOVA Table

Factors	S.Em. ±	C.D. (5 %)	C.V. (%)
A- (Union fabrics)	0.23	0.68*	0.65
B- (Total weight, warp and weft)	0.15	0.43*	
A × B- (Union fabrics) × (total weight, warp and weft)	0.33	0.96*	

*- Significant at 5 % level of significance: CD- Critical difference; CV: Coefficient of variation

Data in Table 5 exhibited that, among all the union fabrics especially CB_2 (1.78 mm) possessed highest cloth thickness compared to CC (1.75 mm) fabric which may be because of presence of slubs, snarls of the yarn during the yarn production process and also increase in hairiness of the yarns which adds weight further making a fabric thicker. Similar results were highlighted in a study by Rashmi[5] on value addition to silk floss. Significant difference was found between the fabrics (0.015*) at 5 per cent level of significance.

Table 5: Cloth thickness of cotton × bamboo/tencel union fabrics

Sl. No.	Union fabrics	Cloth thickness (mm)
1.	CC	1.75
2.	CB_1	1.67
3.	CB_2	1.78
4.	CT_1	1.68
5.	CT_2	1.77
S.Em. ±		0.005
C.D. (5 %)		0.015*
C.V. (%)		0.687

*- Significant at 5 % level of significance: CD- Critical difference; CV: Coefficient of variation

Results of Table 6 revealed that cloth stiffness was higher in union fabrics *viz.*, CT_2(6.40 cm) and CB_1 (5.92 cm) fabric compared to CC (4.24 cm) fabric in warp direction which is due to the sizing applied to warp yarns (cotton yarns) prior to weaving thus imparting stiffness in warp direction. Highest single yarn strength of tencel yarn results in higher stiffness which means if the fabric is stiffer; it will take greater time to bend against gravity hence cotton × tencel union fabrics (1.92cm) had higher cloth stiffness in weft direction. Rashmi[5] quoted warp way cloth stiffness was significantly lower than the weft way cloth stiffness as presence of cotton yarns which possessed finer yarn count and more evenness of the yarn.

Table 6: Cloth stiffness of cotton × bamboo/tencel union fabrics

Sl. No.	Union fabrics	Cloth stiffness (cm)	
		Warp	Weft
1.	CC	4.24	1.82
2.	CB_1	5.92	1.74
3.	CB_2	2.64	1.86
4.	CT_1	6.40	1.86
5.	CT_2	4.04	1.92

ANOVA Table

Factors	S.Em. ±	C.D. (5 %)	C.V. (%)
A- (Union fabrics)	0.04	0.12*	4.23
B- (Warp and weft)	0.02	0.07*	
A × B- (Union fabrics) × (warp and weft)	0.06	0.17*	

*- Significant at 5 % level of significance: CD- Critical difference; CV: Coefficient of variation

Creasing is the formation of folds or deformation that is not completely remarkable. The recovery for creasing depends upon the resistance and elastic properties of the material. A fabric must be resilient, which posses certain amount of resistance to creasing but, have a power of rapid recovery. It is perceived from table 7 that, among the fabrics CB_2 (85.80°) fabric had highest crease recovery angle when compared to CB_1 (83.40°) and CT_2 (83.60°) fabric due to the combination of cotton , bamboo and tencel yarns in union fabrics, more unevenness percentage of the yarns and type of weave alters the crease recovery angle in warp way. On the other hand, weft way crease recovery was higher in CB_1 (108.20°) union fabric when compared to CC (84.20°) fabric. This may be due to the stiffness of the union fabrics which makes them more stiff and pliable than the control sample. The results were on par with the study on value addition to silk floss by Rashmi[5].

Statistical results revealed that there a significant difference at 5 per cent level of significance in cloth crease recovery among the fabrics (3.55*), warp and weft direction (2.24*) and interaction among union fabrics and warp and weft directions (5.02*).

Table 7: Cloth crease recovery cotton × bamboo/tencel union fabrics

Sl. No.	Union fabrics	Cloth crease recovery (degrees)	
		Warp	Weft
1.	CC	82.40	84.20
2.	CB_1	83.40	108.20
3.	CB_2	85.80	93.00
4.	CT_1	56.40	106.20
5.	CT_2	83.60	99.20

ANOVA Table

Factors	S.Em. ±	C.D. (5 %)	C.V. (%)
A- (Union fabrics)	1.24	3.55*	4.45
B- (Warp and weft)	0.78	2.24*	
A × B- (Union fabrics) × (warp and weft)	1.75	5.02*	

*- Significant at 5 % level of significance: CD- Critical difference; CV: Coefficient of variation

CONCLUSION

Mechanical properties *viz.*, cloth stiffness, cloth crease recovery, cloth thickness of the union fabrics was found to be higher when compared to cotton ×cotton fabric. Union fabric is a combination of using two different types of constituent fibres/yarns which enhances the fabric performance thus increases its storage period.

Cotton is the most user-friendly fabric in nature as it provides most of the functional or comfort properties which enhances the work efficiency of the wearer. Thus utilization of bamboo and tencel yarns in order to develop union fabrics enhances fabric properties and makes the fabrics more durable and stronger.

REFERENCES

1. Booth, J. E., Principle of textile testing: An introduction to physical methods of testing textile fibres, yarns and fabrics. *CBS Publisher and Distributers*, New Delhi, pp. 209-253 (1996).
2. Christy, B. and Kavitha, S., Go-green textiles for environment. *Advanced Engg. and Appl. Sci. An Int. J.*, **4 (3):** 26-28 (2014).
3. Jayalakshmi, I. and Soudanyaa, D., A study on the impact of bamboo material using natural dyes. *Man –made Textiles in India*, 465-472 (2015).
4. Sadhana, D. K., Utilization of naturally colour linted cotton yarns in the handloom sector to produce union fabrics. *PhD. Thesis*, Univ. Agric. Sci. Dharwad, Karnataka (India) (2004).
5. Rashmi, P., Value addition to silk floss. *M.Sc. Thesis*, Univ. Agric. Sci. Dharwad, Karnataka (India) (2016).