Available online at www.ijpab.com

DOI: http://dx.doi.org/10.18782/2320-7051.7039

ISSN: 2320 – 7051

Int. J. Pure App. Biosci. **6 (5):** 827-831 (2018)

Research Article

International Journal of Pure & Applied Bioscience

OPEN ACCESS

Quality Analysis of Comfort Properties of Cotton X Bamboo/Tencel Union Fabrics

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Received: 14.09.2018 | Revised: 20.10.2018 | Accepted: 26.10.2018

ABSTRACT

Nowdays consumers are being more conscious and careful about their health and living style. Consumers tend to be more careful about clothing comfort particularly functionality of the clothing worn by them. Comfort contributes to all essential factors viz., physical, psychological, mental and social wellbeing. If clothing worn does not serve its purpose it creates the hindrance in our working efficiency. Thus in order to study the comfort properties of the developed union fabrics, cloth air permeability, cloth thermal insulation values and cloth wick up test method were studied and the results indicated that, union fabrics possessed better comfort properties than the cotton × cotton fabrics (control). Whereas, lesser the yarn counts better thermal insulation value of union fabrics and higher the yarn counts better the air permeability. Similarly, irrespective of different counts and different yarns used, the wicking behaviour of all the fabrics increased with increase in wicking time. Thus this study depicts that use of bamboo and tencel for developing union fabrics with cotton tends to have better comfort properties and as it is noted better comfort enhances the wearers physiological and mental well being which further enhances their personality and also their working efficiency.

Key words: *Comfort, Bamboo, Tencel, Cotton.*

INTRODUCTION

Nowdays standard of living is getting higher thus, making consumer more demanding with the need of comfort than durability. As comfort plays an important role in selection of apparel thus it becomes one of the most important aspects of clothing. Properties like thermal insulation, air permeability and wick-up test are critical for the thermal comfort of a covered body. The demand from fabrics has changed with the developing technologies and the rising standard of living. These days consumer's major focus is more on comfort property which includes psychological, sensorial and thermo-physiological comfort than durability.

It is evident that fibre types, yarn properties, fabric structure, finishing treatments are the main factors affecting clothing comfort. Bamboo fibre is a regenerated cellulosic fibre produced from bamboo pulp.

Cite this article: Medar, R. and Mahale, G., Quality Analysis of Comfort Properties of Cotton X Bamboo/Tencel Union Fabrics, *Int. J. Pure App. Biosci.* **6(5):** 827-831 (2018). doi: http://dx.doi.org/10.18782/2320-7051.7039

The type of bamboo used for apparel is "Moso bamboo". With the growing demand for more comfortable, healthier and environmental friendly products efforts in the research and development activities in textile industry focuses on usage of renewable and biodegradable resources in textiles. Bamboo and tencel being regenerated in nature possess greater water absorbency and has a tendency of absorbing water three times of weight of water. Thus studying the comfort properties is essential in order to be selective in the apparel purchasing practices[3].

Apart from protection, it is important to study the comfort properties of the clothes are worn because human body produces a lot of heat energy resulting in increase in body temperature[2]. Thus studying the wickability is also important as it indicates the amount of perspiration absorbed by the worn clothes which is closely related to the air permeability. Hence, the present study was carried out to study the comfort properties *viz.*, cloth air permeability, cloth insulation values and cloth wicking behaviour of the cotton × bamboo/tencel union fabrics.

MATERIAL AND METHODS

Selection and procurement of yarns

Cotton yarns were procured from KHDC Gadag, Karnataka while bamboo and tencel yarns were procured from Pallava Textiles, cotton mill, Tamil Nadu.

Weaving of union fabrics

Weaving is the method of fabric production wherein, two sets of yarns are interlaced at right angles to each other. Two types of plain woven union fabrics were produced on a pit loom at Malali Village, Ramapur, Karnataka. Cotton yarn was used as warp and bamboo and tencel yarns were used as weft. Five fabrics were woven *viz.*, cotton × cotton (CC), cotton × bamboo 20s (CB_1), cotton × bamboo 30s (CB_2), cotton × tencel 20s (CT_1) and cotton × tencel 30s (CT_2). All the samples were conditioned under standard atmospheric conditions and were tested using standard test methods. The testing methods are explained in detail below.

Cloth thermal insulation value

Thermal resistance is the ability of a material to resist the flow of heat. Thermal resistance is the reciprocal of thermal conductance *i.e.*, lowering its value will raise the heat conduction and vice-versa. The specimens were tested manually. The experiment was carried out by cooling method. In this method, a hot body is wrapped with the fabric and its rate of cooling is measured. The outer surface of the fabric is exposed to the air. The experiment consists in finding the time taken by a hot body covered with the fabric sample without the sample to cool through a particular temperature range under identical atmospheric conditions. The experiment was started when temperature of the water was exactly 48°C. A stop watch was used to find the time taken for the temperature to fall at 38°C. Further the reduction; in temperature the heat loss/seconds can be determined for covered and uncovered cylinder.

$$TIV = \frac{100\,(Ho - Hc)}{Hc}$$

Where,

Ho= Heat loss/sec. from uncovered surface

Hc = Heat loss/sec.from covered surface.

Cloth Air permeability

Air permeability is defined as the volume of air measured in cubic centimeter passed per second through 1 cm^2 of the fabric at a pressure of 1 cm of water. All the samples were tested as directed by ASTM D-737 test method. Air at standard atmosphere was drawn from labrorartry through the test specimen by means of a suction pump, the rate of flow being controlled by means of the pass valve and service valve at the definite pressure. The rate of flow was adjusted until the required pressure drop across the fabric and is indicated on a draught gauge. The rate of flow of air was then recorded by rotameter from the instrument. The experiment was carried out at DKTE, Ichalkaranji.

Cloth wick up test

The ability of a fabric to absorb water, especially by 'wicking' or 'capillary action' may be observed by timings, the rate at which water rises into the a narrow strip of fabric suspended vertically with its lower end dipped into the water[5]. The size of the test sample is 7”× 1” (L×W), cut separately warp way and weft way. Each strip was suspended alongside of a ruler with one inch immersed in 1 litre of acid dye solution (50 mg Sandol, Rhodine E-2GL) to a hook of 4 g weight to keep the sample straight. The height (length) of rise of liquid in 1, 2 and 5 minutes were observed and recorded.

RESULTS AND DISCUSSIONS

Comfort properties are very essential with respect to clothing as it may hinder our day to day activities while on work. Results of the comfort properties *viz.,* cloth thermal insulation value, cloth air permeability and cloth wicking length are discussed as under.

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

Sl. No	Union fabrics	Direction	Fiber Content	Yarn type	Twist Direction	Yarn count	Threads per inch	Weave
1	Cotton × Cotton (CC)	Warp	Cotton	2 ply	Z	2/20s	48	Plain
		Weft	Cotton	2 ply	Z	2/20s	26	
2	Cotton × Bamboo (CB_1)	Warp	Cotton	2 ply	Z	2/20s	51	Plain
		Weft	Bamboo	2 ply	Z	20s	23	
3	Cotton × Bamboo (CB_2)	Warp	Cotton	2 ply	Z	2/20s	50	Plain
		Weft	Bamboo	2 ply	Z	30s	26	
4	Cotton × Tencel (CT_1)	Warp	Cotton	2 ply	Z	2/20s	50	Plain
		Weft	Tencel	2 ply	Z	20s	23	
5	Cotton × Tencel (CT_2)	Warp	Cotton	2 ply	Z	2/20s	50	Plain
		Weft	Tencel	2 ply	Z	30s	27	

Constructional details of cotton × bamboo/tencel union fabrics explain about the constructional parameters of yarns and specific information of the fabrics. Cotton × bamboo/tencel union fabrics 2ply cotton 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 to weave plain woven union fabrics. Cloth count was found to be higher in all union fabrics (50) in warp direction when compared to the CC (48) fabric. On the other hand, weft way cloth count was found to be on par in union fabrics (27) except CB_1 and CT_1 (23) fabrics (Table 1).

Table 2: Cloth thermal insulation value of cotton × bamboo/tencel union fabrics

Sl. No.	Union fabrics	Cloth thermal insulation value (tog)
1.	CC	27.34
2.	CB_1	29.60
3.	CB_2	23.84
4.	CT_1	27.42
5.	CT_2	26.34
S.Em. ±		0.01
C.D. 5 %		0.03*
C.V. (%)		4.92

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

Table 2 expresses that the cloth thermal insulation value of CB_1 (29.60 tog) fabric depicted higher value compared to the CC (27.34 tog) fabric because as cotton is a good conductor of heat, cotton and bamboo both being cellulosic in nature have the tendency to retain heat energy and combining the properties of both cotton and bamboo results in good thermal insulation value of the union fabrics. The results of value addition to silk floss by Rashmi[4] was on par, stating that, maximum thermal insulation value was observed in union fabrics may be due to the combined effect of cotton and silk floss resulting in higher thickness.

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

Sl. No.	Union fabrics	Cloth air permeability ($cm^3/cm^2/sec$)
1.	CC	58.32
2.	CB_1	43.38
3.	CB_2	76.26
4.	CT_1	69.28
5.	CT_2	75.28
S.Em. ±		0.01
C.D. 5 %		0.03*
C.V. (%)		3.31

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

The results presented in Table 3 depicted that, CT_2 and CB_2 union fabrics attained highest cloth air permeability which may be due to the count (30s) and compactness of the weave. It is strengthened that, higher the yarn count, finer the yarn thus allowing more air to pass through the interstice spaces of the fabrics. Further, loosely woven fabric creates more spaces for air to pass through the fabric structure thereby increasing the air permeability. On the other hand, union fabrics of 20s count were less permeable to air because of the use of coarser yarns and compactly woven fabric structure.

Table 4: Cloth wick up length of cotton × bamboo/tencel union fabrics

Sl. No.	Union fabrics	Cloth wick up length (cm)					
		1 min		2 min		5 min	
		Warp	Weft	Warp	Weft	Warp	Weft
1.	CC	1.74	3.78	3.12	4.72	5.00	6.44
2.	CB_1	1.54	1.66	2.64	4.06	4.16	4.84
3.	CB_2	1.58	2.00	2.34	2.36	3.14	2.92
4.	CT_1	1.34	2.38	2.40	2.38	3.58	4.20
5.	CT_2	2.68	2.2	3.32	3.66	4.54	4.04

ANOVA Table

Factors		S.Em. ±	C.D. (5 %)	C.V. (%)
A	- (Union fabrics)	0.02	0.08*	5.00
B	- (1, 2 and 5 mins)	0.02	0.08*	
C	- (warp and weft)	0.01	0.05*	
A × B	- (Union fabrics) × (1, 2 and 5 mins)	0.05	0.14*	
A × C	- (Union fabrics) × (warp and weft)	0.04	0.11*	
B × C	- (1, 2 and 5 mins) × (warp and weft)	0.03	0.08*	
A × B × C	- (Union fabrics) × (1, 2 and 5 mins) × (warp and weft)	0.07	0.21*	

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

Wicking property of a fabric mainly depends on fibre characteristics and structure of component yarns and fabrics. Table 4 reveals that, CT_2 fabric showed highest wicking length in warp direction (2.68cm) followed by CC (1.74 cm) and CB_2 (1.58cm) fabrics at one minute wicking length. However, CC depicted highest wicking length in weft direction (3.78cm) followed by CT_1 (2.38cm) and CT_2 fabrics (2.20 cm) at one minute wicking time. Meanwhile, CT_1 fabric (3.32 cm) attained highest wicking length followed by CC (3.12 cm) and CB_1 (2.64 cm) fabrics in warp direction whereas, CC (4.72 cm) fabric attained highest wicking length in weft direction followed by CB_1 (4.06 cm) and CT_1 (3.66 cm) fabrics at two minute wicking length. On the other hand, CC fabric obtained highest wicking length both in warp (5.00 cm) and weft direction (6.44 cm) at 5 minute wicking time followed by the remaining union fabrics. It is observed that as the wicking time increased the wicking length of all fabrics also increased which may be due to the yarn structure, type of twist, yarn cohesiveness and also the amorphous and crystalline nature of the fibre structure. As more the amorphous region better absorbency and higher the crysatllinity lesser the water uptake in the fibre structure ultimately affects the wicking behaviour of the fabrics. Kandi *et al.*[1]stated that wickability increases with increasing bamboo content in blends and also wickability was observed to be highest in warp direction when compared to weft direction.

Statistical results explained that, significant difference was found between the fabrics (0.08*), between the time intervals (0.08*), in warp and weft direction (0.05*), combination of fabrics and timings (0.14*), union fabrics with warp and weft direction (0.11*), between timings with warp and weft direction (0.08*) and between the union fabrics, timings with warp and weft directions (0.21*) at 5 per cent level of significance.

CONCLUSION

Clothing comfort can be explained through the absorbent behaviour of the fabrics, thermal insulative capacity and air permeable nature of the fabrics. Wherein amount of heat permissible, amount of air permeable to the wearer and the wicking method explains the extent to which fabric possess better comfort properties. Cotton, bamboo and tencel being cellulosic in nature tend to provide better comfort to the wearer. The results obtained from the study depicts lesser the counts of bamboo and tencel yarns of union fabrics better thermal insulation values, on the contrary, higher the counts of bamboo and tencel yarns of union fabrics better the air permeability. While irrespective of different counts and different yarn used the wicking behaviour of all the fabrics increased with increase in wicking time.

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