To Study the PET/Bamboo & PET/Cotton Blend Yarn to Made for the Knitted Fabric on Comfort Properties Behavior: Part-I

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Abstract

Comfort is one of the most essential aspects of clothing, so properties such as air permeability, water vapour permeability, and liquid water permeability are critical for a clothed body's comfort. In this research work the effect of yarn count, types of fibre and blend composition on fabrics properties made from Polyester/bamboo and Polyester/cotton blended yarn has been studied. Three types of blend of polyester/bamboo and polyester/cotton (80/20, 65/35, 50/50) are used for 20s and 30s Ne yarn preparation. However, as cotton content percentage increases in the blend, imperfections, hairiness, unevenness & increases. Hairiness value decreases with increase in bamboo content % in blend. Water vapour permeability is higher in polyester/bamboo fabric as compared to polyester/cotton blended fabrics.

Keywords: Knit Fabric; Water Vapour Permeability; Imperfections & Mass Irregularity; Hairiness.

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1. Introduction

In last ten years the technology is changed a lot of, the demand of fabric is also changed and the changes in the cloth comforts in which sensorial, psychological and thermo physiological comfort. It is now not only about style and durability. The factors on which comfort is based are types of fibre, fabric structure, yarn properties, finishing treatments and clothing conditions [1]. Fabric's thermal comfort is controlled by the heat movement, flow of moisture and air through the fabric. To increase the properties of resultant yarn type and to reduce the cost of the raw material blending of different fibres is done which is a common practice in the spinning industries. The percentage of fibres in the blend have effect on various properties and besides it, the properties of blended yarns are affected by the properties of the constituent fibres and their compatibility. Further, it is observed that the stronger fibres have to be blended at least by a certain percentage in order to increase the tensile properties [2, 3]. Bamboo has a number of particular properties like anti-static property , inherent antibacterial property (a single antiseptic and bacteriostatic bio-agent known as "Bamboo Kun" is strongly combined with bamboo cellulose molecules and remains during the process of being produced into bamboo fibre) and good UV defense [4, 5]. Bamboo cellulose fibres that have been regenerated provide excellent comfort in a variety of applications. Innerwear, hygienic goods, home furnishings, sanitary fabrics, and nonwovens all use regenerated bamboo fibre these days [6, 7]. Eco friendly processes have been developed for the bleaching of fabric with a viewto reduce the water consumption and processing time. There is no significant difference in thewhiteness values. Further, by employing eco-friendly processes, there is significant decrease involume of effluent generated [8, 9, 10].Although considerable research work carried out on study of cotton and bamboo fibres for apparel applications but limited work available on blended fabrics with finishing treatment like enzymatic finishing. Hence, in this research work, yarns and fabrics made from different blends of polyester/ bamboo and polyester/ cotton have been studied and analysed in grey and Bio- Finished stage. Due to the increasing demand for knitted garment these days, knitted fabrics have been produced and studied.

2 Materials and Methods

2.1 Raw Material

In the present study the various elements of textile material have been taken into account. For the blended fabric sample preparation three fibers used are Bamboo, Polyester and Cotton. Polyester fibers in various proportions are blended with two different fibres.

2.1.2. Fibres Parameters

Table 1 Specification of fibres

Fibre	Length (in mm)	Fineness	Tenacity (gpd)	Short fibre %	Elongation %
Bamboo	38	1.54 D	2.5	-	20.8
Cotton	30	3.5mic/1.23D	3.5	7.5	5.3
Polyester	38	1.38 D	5.8	-	24

2.1.3. Preparation of yarn samples

20s Ne and 30s Ne yarns were prepared in the ratio of (50:50, 65:35, 80:20) using blend of Bamboo and cotton fibre with Polyester. A uniform blend of polyester/bamboo and polyester/ cotton is produced by manual opening and mixing. The ratio taken blending of Bamboo and Cotton fibres with polyester is (50:50, 65:35, 80:20) for Polyester : Bamboo and (50:50, 65:35, 80:20) for Polyester : Cotton. By blending, the functional properties, process performance properties get improved and also it helped in the reduction of cost of mixing. In a Lakshmi Rieters blow room line a predetermined quantity of fibres were mixed and processed.

2.1.4. Fabric samples preparation

The above P/B and P/C yarns were used to make fabric, the no. of different samples were twelve, by using 20s Ne & 30s Ne using circular knitting machine of single jersey. These samples were prepared from polyester/Bamboo and Polyester/Cotton in two set.

Table 2 Specification for the Polyester/Cotton and Polyester/Bamboo fabrics

S.No.	Blend ratio & samples	Count (Ne)	GSM (g/m^2)	Stitch length (mm)	WPI	CPI	Stitch density	Thickness (mm)
1.	80/20, PET/Cotton	20s	275	3.5	42	35	1470	0.672
2.	65/35 PET/Cotton	20s	270	3.5	42	37	1554	0.652
3.	50/50 PET/Cotton	20s	270	3.5	42	37	1554	0.652
4.	80/20, PET/Bamboo	20s	265	3.5	41	36	1476	0.641
5.	65/35 PET/Bamboo	20s	268	3.5	41	37	1517	0.651
6.	50/50 PET/Bamboo	20s	272	3.5	42	35	1470	0.662
7.	80/20, PET/Cotton	30s	228	3.5	47	42	1974	0.621
8.	65/35 PET/Cotton	30s	220	3.5	47	43	2021	0.601
9.	50/50 PET/Cotton	30s	218	3.5	46	44	2024	0.602
10.	80/20, PET/Bamboo	30s	221	3.5	47	73	2021	0.599
11.	65/35 PET/Bamboo	30s	224	3.5	47	42	1974	0.611
12.	50/50 PET/Bamboo	30s	226	3.5	47	41	1927	0.612

2.1.5. Bio-finishing treatment

In bio-finishing, 1% concentrated cellulose enzyme was used and 2g/l acetic acid was added in the bath to make a 5.5 pH buffer solution. The fabrics were treated at a liquor ratio of 1:20 for 60 min at 55˚C.Then Na2Co3 was being added to the solution for deactivation by raising the temp up to 70°C for 15 min. After finishing, hot wash was done for 15 min followed by cold wash with addition of acetic acid for neutralization and then washed thoroughly with cold water and samples were air dried and conditioned.

2.2 Methods

Before testing, the conditioning was done for 48 hours of all samples in standard atmospheric condition where temperature was 27 ± 2°C and relative humidity 65 ± 5% as per standards.

2.2.1 Water vapour permeability

This test was carried out by cup method of water vapour permeability. As per the standards of British version the fabric sample for testing is fit over the open mouth of a pot like cup which is was filled with water and this was kept under standard atmospheric condition for testing [BS7209]. This water pot is then weighted after a time period when it will achieve equilibrium and after that the calculation was done of water vapour transfer rate from the specimen.

The index of water vapour permeability is determined as a percentage of the WVP of a standards fabric sample which is taken as a reference fabric along with the test specimen. The level of water in each pot is kept 10mm empty, which is kept for the air gaps between the fabric and water surface. For maintaining the fabric level a sample of wire is placed on each pot which gives the support to the fabric. Glue is applied to the specimen and mouth of pot, the diameter of sample is 96mm and it is kept on the top at its outside surface. This fabric is covered with ring and over the pot, the space between ring and pot surface is sealed by the PVC tape. The pot which is covered by another reference fabric is too prepared as like the sample fabric. All these pot are than kept in the standard atmospheric condition for testing and kept here for about 1 hour to achieve the equilibrium. Weight of every pot is then taken nearest to 0.001g by noting the time. After keeping the pot for approximately 12 hours the weights of pots are again measured by noting the time also.

Calculations

WVP = 24x W/At (g/m²/day) …….(1)

Where, W = loss in mass (g), A = internal area of disk (m2), t = time between weighing (h),

$$A = \frac{\pi d 2.10^{-6}}{4} \quad \ldots\ldots.(2)$$

Where, d =diameter of disk from internal side (mm)

The ASTM E 96-80 [47] an another method B is same as like the above method in which the gap for air in between the fabric and water surface 19mm (0.75 in) and a velocity of air of 2.8 m/s (550ft/min) is used on the fabric surface. The gap between the sample and water surface is important in these tests because air is also a higher WVP resistance [ASTM E96-80]. There are three factors on which set-up of experiment of total resistance to WVP depend.

Sometimes the experiment is carried out with the help of inverted cup in which the fabric inner surface is in contact with water [P.W.Gibson, 1993]. More favourable results can be found in favour with the hydrophilic fabrics by this method.

2.2.2 Imperfections and mass irregularity

In both types of yarns for the measurements of imperfections and mass irregularities the yarn at a constant speed was passed in between two capacitance plates. The principle of UT5 is measurement of capacitive. The change in mass of yarn is modified into an electrical signal. Now this electrical signal modified into another signal which is known as digital signals. UT5 computer then directly store and

process these digital signals. The measurement of hairiness is then measured by UT-5 throughout the length of yarn.

2.2.3 *Tenacity*

Testing of yarns for tenacity was done using Uster Tenso Rapid-4 as per the standard (ASTM D-1578, JIS). TENSO RAPID-4 automatically gives some specific information about the yarn tenacity. During Testing the yarn sample is hold by two jaws, out of which 1st top jaw is attached with load cell and bottom jaw is moving down with a standard speed. The machine automatically calculates the breaking load for each sample.

2.2.4 Hairiness

The hairiness measuring system according to UT-5 measures the entire length of yarn. The hairiness value of UT-5 is called H (Hairs/cm).Mass irregularity and imperfections of both types of yarns were determined according to ASTM standards (D 1425/1425M-14) by Uster Evenness Tester-5 (UT-5). It is based on photo cell principle and is used to detect the fibres protruding from the surface as hairs of the yarns. The yarn to be tested it passed through the tensioners and between the photocell. As the yarn is drawn over the thread guide the projecting fibres interrupt the light beam. The resulting signal from the photocell is amplified, counted and displayed on the counter (ASTM D1425).

3 Results and discussion

3.1 Yarn properties

3.1.1 Unevenness % & Imperfections

It has been observed from Table 3 that the change in blend percentage in yarn influences unevenness & imperfections for both yarn counts. Further as the blend percentage of cotton increases in both (20s & 30s) yarn unevenness % increases, it is due to the higher percentage of short fibres content present in the cotton leading to floating fibres generation in the drafting zone. However as the proportion of bamboo fibre in blend increases no significant change has been observed in both the count as per unevenness is concerned.

It can be observed from Table 3 the imperfections values of Polyester/Cotton yarn found to increase with increase in the proportion of cotton fibre in both count due to the short fibre percentage. As far as Polyester/Bamboo yarn is concerned, total imperfections are lower as compared to Polyester/Cotton yarn as reported earlier.

Table 3 Unevenness (U %), imperfections of polyester-bamboo and polyester- cotton blended ring spun yarn

Yarn count (Ne)	Blend	U%		Imperfections per kilometre							
		Polyester/ Cotton	Polyester/ Bamboo	Polyester/Cotton				Polyester/Bamboo			
				-50%	+50%	+200%	Total	-50%	+50%	+200%	Total

20^s	**80/20**	11.33	10.02	10.0	27.0	17.0	54	2.50	17.5	5.00	25
	65/35	11.25	11.27	2.50	47.5	15.0	65	3.50	22.5	25.0	51
	50/50	12.30	11.79	5.00	27.0	25.0	57	0.0	25.0	20.0	45
30^s	**80/20**	12.24	11.42	30.5	25.0	41.5	96.5	15.0	27.5	22.5	65
	65/35	15.07	11.26	2.90	75.5	25.0	78.4	2.50	67.5	7.50	77.5
	50/50	14.23	10.45	8.50	37.0	77.5	123	0.0	45.0	42.5	87.5

3.1.2 Tenacity

It has been observed from Table 4 that the influence of change of fibre proportion of cotton and bamboo in the blended yarn affect tenacity. Further as bamboo and cotton fibre percentage in the blend increases, tenacity of yarn decreases. It may be due to the low tenacity of cotton and bamboo fibres and subsequently weak inter fibre cohesion of cotton and bamboo fibre in the resultant yarn because the fibre strength plays a key role in the yarn strength. Polyester/bamboo blended yarns have 18% (approx.) higher tenacity than polyester/cotton blended yarns.

3.1.3 Hairiness

It has been observed from Table 4 that yarn hairiness decreases as the % age of bamboo fibre increases when compared with cotton blended yarns. It may be explained in the light of fibre flexural and torsional rigidity. Cotton fibres have higher flexural and torsional rigidity as compared to bamboo fibre. Hence, wrapping of bamboo fibre is easier in the yarn body leads to lower yarn hairiness in P/B. There is a reduction in yarn hairiness when the %age of bamboo in increased. Polyester/bamboo blended yarns have 6% lesser hairiness than polyester/cotton blended yarns. A marked reduction is observed in hairiness with increase in linear density from 20s to 30s. The number of fibres reduces in the same blend proportion as the yarn becomes finer.

Table 4: Tenacity & hairiness of polyester-cotton polyester-bamboo blended ring spun yarn

Yarn Count (Ne)	**Blend**	**Tenacity GPT**		**Hairiness(UT-5)**	
		Polyester/ Cotton	**Polyester/ Bamboo**	**Polyester/ Cotton**	**Polyester/ Bamboo**
20^s	**80/20**	25.75	33.75	7.12	5.55
	65/35	23.75	28.17	8.15	6.23
	50/50	22.48	25.83	9.45	6.45
30^s	**80/20**	32.35	31.25	6.23	6.15
	65/35	23.24	29.89	6.95	5.96
	50/50	20.25	28.36	7.45	6.85

The effect of all experimental factors, viz. Fibre type, Blend, Yarn count & finishing treatment on fabric properties viz. abrasion resistance, bursting strength, pilling resistance, have been analysed.

3.2. Water vapour permeability

The effect of blend, count, fibre type & finish on water vapour permeability of the fabrics is represented in Table 5 and Figure 1. It has been observed that as the percentage of bamboo and cotton fibres increases in the blend, water vapour permeability of fabrics also increases. WVP is higher in polyester/bamboo blends as compared to polyester/cotton blends. It may be due to the higher moisture regain and micro porous structure of bamboo fibre.

The WVP of the fabrics decreases as the count of the yarn increases. It may be due to the higher TPI of the yarn in these fabrics; which results more compactly packed fibres in the yarn. The WVP of the bio-finished fabrics is different for both polyester/cotton and polyester/bamboo blends. In case of polyester/bamboo blended fabrics water vapour permeability increases, it is explained in the light that these yarns produce a less hairy and compact structure which provides great inter-yarn space. On the other hand water vapour permeability reduces after bio-finishing for polyester-cotton blend, this may be due to the reduction of yarn inter-yarn space and pore size after finishing, because cotton component shrinks after finishing treatment.

Table 5 Effect of count, blend, fibre type & finishing on water vapour permeability of polyester-cotton and polyester-bamboo blended fabrics

Yarn Count (Ne)	Blend	Water Vapour permeability before Bio-Finishing (gm/m²/day)		Water Vapour permeability after Bio-Finishing (gm/m²/day)	
		Polyester/ Cotton	Polyester/ Bamboo	Polyester/ Cotton	Polyester/ Bamboo
20s	80/20	1145.27	1195.30	1175.46	1405.29
	65/35	1427.18	1475.40	1255.32	1625.67
	50/50	1717.74	1805.25	1493.87	1945.55
30s	80/20	1050.90	1215.55	1050.90	1254.78
	65/35	1465.60	1350.45	1186.75	1385.71
	50/50	1687.58	1445.54	1365.92	1652.29

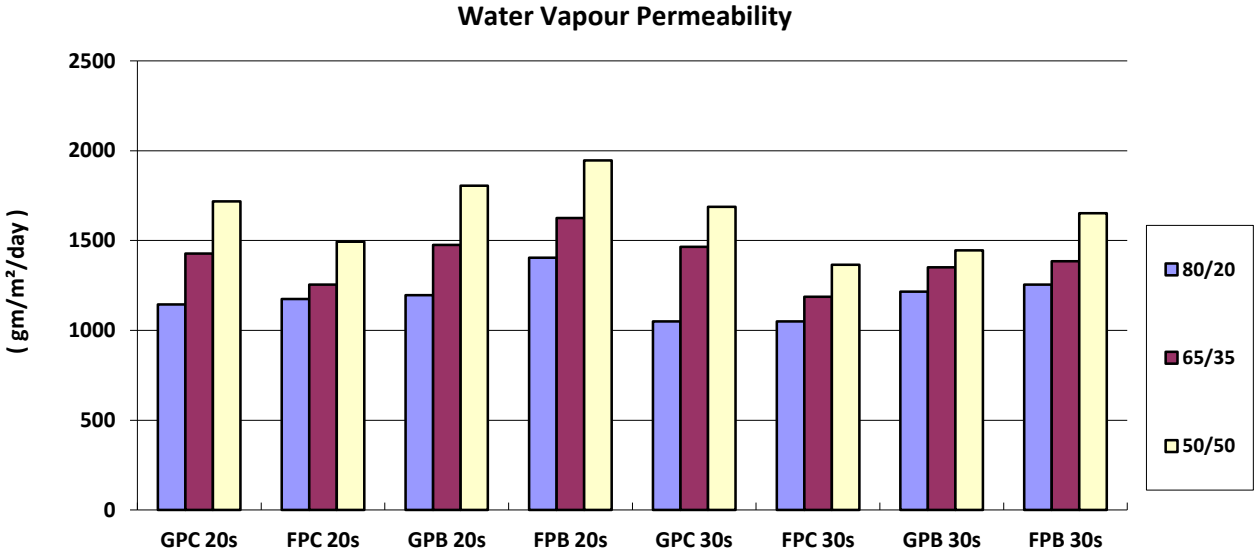

Figure 1 Effect of count, blend, fibre type & finish on water vapour permeability of fabrics

4 Conclusions

- Effects of Fibre: The polyester/bamboo blended yarns are not similar to polyester/cotton blended yarn in terms of their mechanical and physical properties. Bamboo blended fabrics have higher values of water vapour permeability rather than cotton blended fabrics.
- Effect of Blend: Water vapour permeability increase as bamboo and cotton % age increases.
- Effect of Count: As linear density increases water vapour permeability reduced.
- Effect of Bio-finishing: Grey Polyester/bamboo blended fabrics have higher values of water vapour permeability rather than polyester/cotton blended fabrics
- Bio- finished polyester/bamboo fabrics lower reduction in water vapour permeability is observed. For the apparel purpose 20s Polyester/bamboo is better compare to other fabric, this is due to its better moisture related properties.

References

[1] Ajay Rathod and Avinash Kolhatkar.Analysis of physical characteristics of bamboo fabric. International Journal of Research in Engineering and Technology, 3(8), 21-25, (2014)

[2] Ahu Demiroz Gun. Dimensional, Physical and thermal properties of plain knitted fabrics made from 50/50 blend of modal viscose fiber in microfiber form with cotton fiber. Fibers and Polymers, 12(8), 1083-1090, (2011)

[3] Sampath, M. B., Aruputharaj, A., Senthilkumar, M., and Nalankilli, G. Analysis of thermal comfort characteristics of moisture management finished knitted fabrics made from different yarns. Journal of IndustrialTextiles, 42(1), 19–33, (2011)

[4] C. Prakash1, G Ramakrishna and C V Koushik. Effect of blend ration on quality characteristics of bamboo/cotton blended ring spun yarn. Daffodil Int University J Sci Tech, 7(1), (2012)

[5] P. Kandhavadivu, R Rathinamoorthi and R Surjit.Moisture and thermal management properties of woven knitted tri-layer fabrics.Indian Journal of Fibre Textileand Research, 40(1), 243-249, (2015)

[6] P. Kandhavadivu, R Rathinamoorthy & R Surjit. Thermoregulatory characteristics of bamboo / lyocell union fabrics," Indian Journal of Fibre Textile and Research, 39 (2), 386-393,(2014)

[7] G.K. Tyagi, S. Bhattacharaya & G. Kherdekar.Comfort Behavior of Woven Bamboo-Cotton Ring and MJS Yarn Fabrics. Indian Journal of Fibre Textile and Research, 36(1), 47-52, (2011)

[8] Mishra S P. A Text book of fibre science and technology.New Age Int limited, K Gupta, New Delhi, (2000)

[9] M. Latha, N. Sangeetha. Role of natural enzymes and their applications in textile whitening research paper. International Journal of Management Social Science Research Review 1(2), 79-84, (2015)

[10] Khushboo Shrimali1, Ela Dedhia. Enzymatic Finishing of Textiles.International Journal of Science and Research (IJSR) 5(1), 1-6, (2016)