

HIGH PERFORMANCE & COLOUR STRENGTH BEHAVIOR OF BAMBOO/POLYESTER BLENDED WOVEN FABRICS

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Abstract

In this work, the High performance & colour strength Behaviour of bamboo & polyester woven fabrics have been studied in relation to weave and % of component fibers in the blends. The objective was to determine the influence of fabric factors such as weave and the constituent fibers characteristics on the fabric properties such as anti-bacterial activity, ultra-violet protection ability, dye take up and capillarity have been studied. The experimental results show that 2/30s bamboo in warp way of twill woven fabric exhibits higher anti-bacterial activity, ultra-violet protection ability, dye take up and capillarity when compared to other samples

Keywords: *high performance, colour strength, weave type, % component fibres, anti-bacterial activity, ultra-violet protection ability and dye take up.*

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1. INTRODUCTION

The demands from fabrics have changed with the developments in technology and the rising living standards. Now the requirement is not only style, durability and comfort, but also hygienic related property of clothing which includes psychological sensorial, thermo-physiological comfort and body protection from sun ray (as ultra violet) and smell odour of fungal growth. It is evident that fibre type, yarn properties, fabric structure, finishing treatment and clothing conditions are the main factors affecting clothing comfort and hygienic property. Bamboo fibre is a regenerated cellulosic fibre produced from bamboo. The type of bamboo used for apparel is Moso bamboo (*Phyllostachys pubescens*). Starchy pulp is produced from bamboo stems and leaves through a process of alkaline hydrolysis and multi-phase bleaching. Further chemical processes produce bamboo fibre. They have got numerous unique properties like inherent anti-bacterial property, a unique anti-bacterial and bacteriostasis bio-agent named bamboo kun is combined with bamboo cellulose molecules tightly and remains all along during the process of being produced into bamboo fibre, good level of ultra violet protection (upf) and anti-static property. Bamboo fibres fabrics are characterized by their good hygroscopicity, excellent permeability, soft feel and easy dyeing. Also bamboo cultivation does not require fertilizers, pesticides and chemical herbicides. They are regarded as a renewable and biodegradable fibre because of their remarkable attributes. Its cultivation requires very little water and it is naturally regenerative. Bamboo is one of the fastest growing plants. It has lesser impact on environmental issues as compared with conventional cotton and other petroleum derived synthetic fibres. Cultivation of conventional cotton involves large quantities of water and

pesticides. So, bamboo fibres can be considered as a potential substitute to conventional cotton and synthetic fibres. Bamboo fibres are 100% bio-degradable. In spite of all these, bamboo fibres have got certain negative attributes like spinners find it difficult to spin 100% bamboo yarns as they produce fly in roving and drawing. Also due to the technology involved in the production of bamboo fibres it is around 2.5 times costlier than cotton. Mechanical process (spinning) is same as viscose fibres. Other properties of bamboo fibres is superior to viscose. In order to avail the positive attribute of the fibres at economical rate, the fibres have been blended with polyester in order to avail the positive attributes of the fibres and to achieve economy we have tried blending bamboo with polyester. The secondary reason for selecting this blend lies in the fact that bamboo fibre has got low tensile strength which decreases further, when it is wet. Now a days, consumer education level is increasing, becoming more & more health conscious and they have become more careful towards their living conditions than they were previously. Bamboo fibre is a new material developed at the beginning of the 21st century. It has many characteristics that meet the current requirement of end uses. But today we still don't know the actual performance behaviour fibres in many application. Modern day living condition require clothing that are hygienic, comfortable, hardwearing & having easy care properties. No, single textile fibres have all thus desirable attributes. Synthetic fibres like polyester have better wear & easy care properties but they lack many of the comfort & hygiene related properties. But regenerated fibres like bamboo have good moisture related properties leading to good comfort as well as good hygiene related properties but they lack wear & easy care properties. So, blended yarns composed of bamboo/Polyester and fabrics produced from them can provide optimum desirable properties.

So, an attempt has been made in this current research to study the high performance, colour strength and capillary of the B/P blended yarns of woven fabrics produced from these.

2. MATERIAL AND METHODS

2.1 Yarn Preparation

Yarns of five different blends along with a 100% bamboo yarn were produced on Lakshmi Rieter ring spinning in TIT MILLS system after proper mixing and blending. The various yarn samples prepared were of blends, 30/70, 40/60, 50/50, 60/40 and 70/30 of bamboo/polyester. The yarns produced were then wound to form cones. All the six yarns were then tested for, strength and elongation, unevenness and hairiness.

2.2. Fabric Preparation

The yarns were woven in Laxmi automatic power loom in TIT&S, Bhiwani laboratory

Make: Laxmi automatic power loom, Dobby M/C speed: 110 m/min

Width: 20 inches. Reed no.: 64, Reed space: 20 inch, Epi-72, Ppi-64

Weft yarn: 6 types of blends as 30/70, 40/60, 50/50, 60/40, 70/30, 100/0 of bamboo/polyester

Warp yarn: 2/30Ne(15°) count of 100% bamboo yarns.

Actual % of bamboo and polyester in the blend in woven fabrics are 67/33, 72/28, 76/24, 81/19, 86/14, 100/0

Two types of fabric (plain & 2/2 twill) were produced from each of the six weft yarns. All the fabric samples were then washed with 2 gpl soda solution & 2gpl soda ash at boil for 30 mins. Subsequently they were hot washed twice and finally cold washed. The pH was maintained at 7. The samples were then dried & ironed for testing purpose.

2.3. Specifications of bamboo and polyester Fibres

Fibre	Fibre length (mm)	Fibre linear density (denier)
Bamboo	38	1.4
Polyester	38	1.4

3. TESTING

The fabrics were conditioned for 24 hours at a temp of 270°C ± 2 & RH of 65% ± 2% as specification. The following fabric tests were carried out for all the six blends: anti-bacterial activity, ultra-violet protection factor, k/s and capillarity

3.1 Anti-Bacterial Activity

Anti bacterial activity: Activity of an antibacterial agent, a measure of effectiveness of the agent.

Antibacterial Agent: Any chemical which kills bacteria (bactericide) or interferes with the multiplication, growth or activity of bacteria (bacteriostat).

Bacteriostat: Chemical additive that limits or prevents the growth of bacteria.

Procedure: The anti-bacterial activity is quantitatively and equivalently evaluated against *Staphylococcus aureus* (AATCC 6538), a gram positive organism, according to AATCC 100 and AATCC 147 test method.

3.1.1 Quantitative Method.

Anti-bacterial test was carried out by the standard AATCC 100-2004, which is also known as Quantitative Method. There are several quantitative methods. They all rely on a basic principle, where a known number of bacteria are placed on a sample, which is then incubated. At the end of the incubation period (usually 24 hours) the number of bacteria remaining is counted. The swatches circular with 4.8 cm diameter are inoculated with 0.1 ml or 0.2 ml of inoculations containing approximately 1,00,000 bacteria/ml. This test specifies that the samples should be tested in replicates of three.

Calculation of the Final Values: The number of bacteria recovered from the treated sample after 24 hours of incubation compared to the number of bacteria recovered from untreated sample immediately after inoculation.

The results are reported as percent reduction using the following equation.

$$R(\%) = 100(B-A)/A.$$

Where, A = The number of bacteria recovered from the inoculated treated test swatches in the jar incubated over the desired contact period.

B = The number of bacteria recovered from the inoculated treated test swatches in the jar immediately after inoculation (at 0 contact time).

R = % Reduction

3.1.2 Qualitative Method

Anti bacterial Test was carried out by the standard AATCC 147, which is also known as qualitative method for Anti bacterial testing or parallel streak method. Specimen of the test materials including corresponding untreated controls of the same material, are placed in intimate contact with nutrient agar which has been previously streaked with an inoculum of a test bacterium. After incubation, a clear area of interrupted growth underneath and along the sides of the test material indicates antibacterial activity of the specimen. A standard strain of bacteria is used which is specific to the requirements of the material under test. *Staphylococcus aureus* is mostly used as a representative of gram positive organism. After the test the incubator plates are examined for interruption of growth along the streaks of inoculum beneath the specimen and for clear zone of inhibition beyond its edge. The average width of a zone of inhibition along a

streak either side of the space specimen is calculated using the equation

$$W = (T - D) / 2$$

Where;

W= Width of clear zone of inhibition in mm.

T= Total diameter of test specimen and clear zone in mm.

D= Diameter of test specimen in mm.

3.2. Ultra Violet Protection Factor

UPF was measured according to the standard AATCC 183 by Spectro-Photometer. The transmission of ultraviolet radiation (UV-R) through a specimen is measured on a spectro-photometer at know wavelength intervals .The ultraviolet protection factor (UPF) is computed as the ratio of the erythemally weighted ultraviolet radiation (UV-R) irradiance at the detector with no specimen to the erythemally weighted UV-R irradiance at the detector with a specimen present.

3.3. Colour Strength (K/S value)

Dyeing procedure

The required amount of disperse dye (pigment form) was dissolved in 50 ml of water with dispersing agent. The solution was heated to 60°C for 15 min. A total of 5 gm of fabric and the dye solution (according to shade % i.e 4%) along with acetic acid to maintain pH 4 to 5 were added to the stainless steel, sealed dye pots, and the total volume was made up to a Material to Liquor

ratio (MLR) of 1:40. Samples were dyed in a laboratory-scale Innolab HTHP dyeing machine. The temperature was raised to 95°C at a gradient of 2.0°C min⁻¹, and then increase to 130°C at a slow rate of 1.0°C min⁻¹ and after that the dyeing was continued for a further 30 min at 130°C. After the hold time of 30 min the samples were taken out and rinsed thoroughly in cold water. Then reactive dyeing is done using reactive dye. The sample is taken in dye bath along with required amount of dye (according to shade % i.e 4%) and raise the temperature to 60°C. then after 15 mins add 10 g/l of sodium chloride as exhausting agent in two installments. After 30 mins add 5 g/l of Sodium bicarbonate (Na₂CO₃) in two installments and run for 30 mins at same temperature. Then a soaping treatment was given with 1-2 g/l soap solution at 90°-95°C for 15 mins to remove unfixed dye from the fabric. Finally hot and cold wash is done and fabric is dried.

The estimation of colour values (K/S value) was done using the D65 source and a 10° observer angle on a computerised Premier Colorscan Spectrophotometer. The colour strength k/s value was assessed using the Kubelka-Munk equation

$$k/s = (1 - R)(1 + R) / 2R$$

Where R is the decimal fraction of the reflance of dyed fabrics

4. RESULT AND DISCUSSION

Table-1 Effect of Blend % on Anti-microbialproperty of bamboo/polyester blended woven fabrics.

Blend	Weave	B (10 ⁶)	A (10 ⁶)	R (%)
bp1	Plain	13	5.2	60.2
	Twill	12	5.9	51
bp2	Plain	14	4.8	65.7
	Twill	19	7.6	60
bp3	Plain	13	0.9	93
	Twill	4.5	1.5	66
bp4	Plain	21	1.7	91.9
	Twill	60	7.4	87.6
bp5	Plain	30	2.4	92
	Twill	18	2	88.8
bp6	Plain	22	1.32	94
	Twill	13	0.93	92.8

Table-2 Effect of blend% on Anti-microbialproperty of bamboo/polyester blended woven fabrics

Blend	Weave	Growth on contact	Zone of inhibition ,mm
bp1	Plain	yes	0
	Twill	yes	0
bp2	Plain	yes	0
	Twill	yes	0
bp3	Plain	yes	0
	Twill	yes	0
bp4	Plain	marginal	0
	Twill	marginal	0
bp5	Plain	no	5
	Twill	no	5
bp6	Plain	no	7
	Twill	no	7

Table 1 and 2 show that The anti-microbial activity increases with increase in bamboo content in both the twill & plain woven fabrics due to inherent anti-microbial property of the bamboo fibres.

It is also observed that the % reduction is bacterial activity is significant for the fabrics when the amount of bamboo in the fabrics is more than about 76%.For 100% bamboo fabrics, the antibacterial activity is very good.

The results from the above tables show that no antibacterial activity is observed for fabrics with less than 70% bamboo fibres

in it. But some anti-bacterial activity and considerable anti-bacterial activity are observed for fabrics having 80% and 90% bamboo fibres respectively (both unwashed and washed). According to literature, 100% bamboo fibre fabric exhibits excellent anti-bacterial activity, but this is not the case with the various blends of bamboo polyester studies over here. As per the study, the content of bamboo in a blend should be greater than 70% in order to retain anti-bacterial property in the fabric. So it can be conducted that their order to retain the anti- bacterial activity of bamboo fibres. So, this adds to limitation of blending polyester with bamboo.

Table-3 Effect of blend% on.UV proction factor of bamboo/polyester blended woven fabrics.

Blend	Weave	MeanUPF	MeanUVA(315-400nm)	MeanUVB(290-315nm)
bp1	Plain	371	0.7	0.2
	Twill	376	0.6	0.2
bp2	Plain	389	0.6	0.2
	Twill	444	0.4	0.2
pb3	Plain	422	0.7	0.2
	Twill	464	0.7	0.1
bp4	Plain	765	0.4	0.1
	Twill	474	0.4	0.2
bp5	Plain	862	0.4	0
	Twill	1246	0.3	0.1
bp6	Plain	1156	0.4	0
	Twill	1722	0.2	0

From the table 3 it is evident that the UPF of the fabrics increase with the increase in bamboo content in the blend. Bamboo fibre has got inherit ability of providing high UV protection to human

skin. So, as the bamboo content increase the UPF of the fabrics increases. Secondly,it can be observed that there is as increase in UPF after washing. The washing compromises 35 wash cycle.

The increases in UPF may be attributed to the shrinking of the cellulosic on washing which results in blocking the pores in the fabrics. The UV transmarine of the blended fabrics also decreases with increasing bamboo content (both UVA and UVB) which further decreases after washing. The percentage of UVB blocking abilities of the fabric should be in 97-99% range even after two years of wear and tear. According to the labelling categories of UV protection for Fabric and garment it has been suggested that an UPF of the more than 40 is considered to be excellent. The results show that all the blended fabrics are equally well UV protective..Effect of blend percentage on UV protection factor of

polyester/bamboo blended woven fabrics (Total range: 290-400) shows that UV protection factor of the fabric is increasing with the increase in bamboo% in the blend. This may be due to higher UPF of bamboo fibres.

For a particular sett, the twill fabric shows more UV protection factor than plain woven fabrics due to higher float length, more thicker & heavier fabric of twill weave structure than plain fabrics.

Table-4 Effect of blend% on k/s value of bamboo/polyester blended woven fabrics

Blend	Weave	k/s value
bp1	Plain	16.89
	Twill	17.21
bp2	Plain	18
	Twill	18.54
bp3	Plain	18.23
	Twill	18.83
bp4	Plain	19.25
	Twill	19.76
bp5	Plain	19.91
	Twill	20.12
bp6	Plain	20.42
	Twill	20.52

The table -4 shows that k/s value of the fabric is increasing with the increase in bamboo% in the blend. This may be due to higher hygroscopic value of bamboo fibres.

For a particular sett, the twill fabric shows more k/s value than plain woven fabrics due to higher float length, more thicker & heavier fabric of twill weave structure than plain fabrics.

CONCLUSIONS

The fabric ant-microbial activity increases with increase in bamboo content in both the twill & plain woven fabrics. The antibacterial activity is significant when the bamboo content in the fabric is more than about 76%.

The UV-protection factor increases with increase in bamboo content in the fabric. Twill fabric exhibits more UV-protection than plain woven fabric.

The colour strength value increases with increase in bamboo content in the fabric. Twill fabric exhibits more colour strength than plain woven fabric

REFERENCES

- [1]. Erdumlu, N. and Ozipek, B. (2008) Investigation of regenerated bamboo fibre and yarn characteristics. *Fibres & Textiles in Eastern Europe*.16: 43-47.
- [2]. kandi I, Das K N and Mahish S S ,Thermo physiological comfort properties of P/B blended suiting fabrics, *International journal of innovative research in science, engineering and technology*, vol.2, issue 12, Dec.2013., pp.7620-7629
- [3]. Nayak RK, Punj S k ,Charterjee K N and Behera B K ,comfort property of suiting fabrics, *Indian Journal of Fibre and Textile Research*. Vol34, pp.122-128, 2009
- [4]. Saravanan, K. and Prakash, C. (2007) Bamboo fibres & their application in textiles. *The Indian Textile Journal*. 117: 33-36.
- [5]. Tyagi, G. K., Bhattacharya, S., and Kherdekar, G. (2011) Comfort behaviour of woven bamboo- cotton ring and MJS yarn fabrics. *Indian Journal of Fibre and Textile Research*. 36:47-52.
- [6]. www. bambooclothes.com.