A Study on the Effectiveness of Bamboo Blended Fabrics on UV Protection for Maternity Wear

P Sasikala, P. Thangamani

Department of Textile Technology, Kumaraguru College of Technology, Coimbatore, India

Abstract: **With the depletion of layer the earth become vulnerable for exposure of harmful UV radiations. The harmful UV rays reduce the effectiveness of folic acid supplementation by 20% with pregnant women. Hence, clothing with inherent property of UV protection is envisaged. In this paper, the UV protection characteristics of bamboo material blended with cotton, polyester and modal are investigated at three levels of fibre ratio. The test results showed that bamboo/modal blends are significantly better than bamboo/cotton and bamboo/polyester fabrics.**

I. INTRODUCTION

The sunlight is important for life and is essential for health, as the human body needs it to form Vitamin-D, improve circulation of blood and resistance to various pathogens. At the same time, sunlight contains ultraviolet rays which pose a major risk potential for the skin. Due to the change in life style of people and spending of leisure time the chances for exposure in sunlight, has increased many fold. The risks posed by ultraviolet radiation have become more dangerous in recent years as the whole world is suffering from all kinds of pollution. Clothing has the ability to shield the skin from incident solar radiation due to its capability of reflection, absorption and scattering solar wavelengths.

Sun emits ultraviolet radiation (UVR), which is a small part of electromagnetic spectrum. UVR is classified into UVA, UVB and UVC categories with wavelength range of 320-400 nm, 280-320 nm and 100-280 nm, respectively. Malik and Arora (1) showed how the UV radiation almost affects all living organisms on earth. Saravanan (2) made a detailed study on the effectiveness of textile materials for UV protection. Achwal (3) studied the mechanisms of textile materials for protection from harmful UV radiations. Adequate amount of UVR exposure helps in production of vitamin D3, but prolonged exposure to UV light is harmful and carcinogenic to humans [3-mantra]. About 130,000 melanoma skin cancer cases and 2 to 3 million humans are diagnosed for non-melanoma skin cancer every year [World Health Organisation, 2014].

In vitro studies conducted by Borrodale et al (4) indicate that folate in collected sample human blood is vulnerable to damage after ultraviolet (UV) radiation exposure. The study conducted in females aged 18-47 years in Australia showed that the effectiveness of folic acid supplementation is reduced upto 20% in overall serum folate with increased solar UV radiation exposures. The consequences may be most pronounced for women who are pregnant or of childbearing age group with high sun exposures. The outcome emphasizes the need for maternity wear with UV protection capability. Hongying Yang et al (5) studied the mechanisms of titanium dioxide as UV blocking additive for fabrics through an improved scheme. Sekar (6) studied the capacity of various UV absorbers in textile materials. El Zaher and Kishk (7) made a study with Nylon-6 films on effect of UV rays in its chemical structure, crystallinity and mechanical properties. Sharma and Singh (8) analysed the effect of dyeing and finishing processes on UV protection of woven fabrics.

Bamboo is a regenerated cellulosic fibre produced by hydrolysis alkalization of bamboo pulp with multi-phase bleaching technology. The fibre has inherent characteristics like high absorbency, anti-bacterial, anti-UV etc. Hence, the clothing produced by bamboo and its blends has been gaining momentum in the international market. When the physical properties of bamboo and cotton are compared many similar characteristics are found (9,10). Micro-pores present in bamboo fibre cross-section support enhanced moisture absorption and ventilation than cotton. The elongation of bamboo is 2-3 times that of cotton and it has high abrasion resistance. Singh and Annika (11) demonstrated that the fabrics produced with different types of yarn configurations and thread count per unit area are also highly influencing UV protection. If these parameters are optimized the fabric can achieve maximum UV protection. The dyeability property of bamboo is also better than cotton. Studies of Jayalakshmi and Soundanya (12) showed that the bamboo fabrics dyed with synthetic and natural dyes exhibited good colour yield and fastness properties. The effect of knitted fabric parameters such as thickness, weight and stitch density, for various single and double jersey structures, on ultraviolet protection of 100% cotton materials was studied by Kan (13). The results revealed that weight per unit area was the most important than any other physical parameters.

II. PURPOSE OF STUDY

Pregnant women are vulnerable to lose serum folate levels on exposure to UV radiation. To protect them, a fabric with

natural UV protection characteristics is envisaged. Bamboo fibre possesses high UV protection property naturally. Blended materials are popular in clothing due its mixed characteristics. Hence, to understand the effect of various textile fibres blended with bamboo in different blend proportions s systematic and scientific study is conducted. The outcome of this work will help to produce a fabric with better UV protection suitable for maternity wear.

III. MATERIALS AND METHODS

Yarns with three different blends viz Bamboo/cotton, bamboo/modal and bamboo/polyester are produced for linear density of 40^s Ne. In each blend, three different blend proportions of yarn samples are made (30:70, 50:50 and 70:30). All the yarn varieties are made with uniform spinning parameters to avoid variations arising due to these factors. With these 9 yarn samples, plain woven fabrics are developed with 28 warp/cm and 24 weft/cm.

Bamboo/cotton and Bamboo/modal fabrics are desized, scoured and bleached in Thies jet dyeing machine by keeping temperature at 80°C for 90 minutes and used 1.5 gpl of Lisapol N detergent solution, 2.5 gpl of hydrogen peroxide, 1.5 gpl of caustic soda and 2 gpl of Finocon as desizing agent. For Bamboo/polyester fabrics caustic soda was replaced with sodium carbonate. After processing, the fabric samples are passed through padding mangle for hydro extraction and relax dried at 120°C. The blend combinations for this study are given in Table 1 with sample codes.

Table 1 Sample parameters

Sample code	Details of Fibre Blend	Ends per cm	Picks per cm	Areal Density (g/sq.m)	Fabric Thickness (mm)
BC1	Bamboo/Cotton (30:70)	28	24	76.5	0.25
BC3	Bamboo/Cotton (50:50)	27	25	76.7	0.27
BC3	Bamboo/Cotton (70:30)	28	25	77.0	0.3
BM1	Bamboo/Modal (30:70)	27	24	75.3	0.26
BM2	Bamboo/Modal (50:50)	28	24	76.0	0.31
BM3	Bamboo/Modal (70:30)	28	23	76.8	0.33
BP1	Bamboo/Polyester (30:70)	29	25	73.4	0.27
BP2	Bamboo/Polyester (50:50)	29	26	74.2	0.26
BP3	Bamboo/Polyester (70:30)	28	25	75.5	0.25

Each fabric was tested to determine its ability to protect from solar radiation through UV transmittance analyser. The critical wavelength for the test was 384nm and the mean values of five readings are tabulated. To determine the Ultraviolet Protection Factor (UPF), procedures of AATCC183:2010 was fully followed. The UPF was calculated as per the following equation (1):

$$UPF = \frac{\sum_{\lambda=290}^{\lambda=400} e(\lambda) \cdot s(\lambda) \cdot \Delta(\lambda)}{\sum_{\lambda=290}^{\lambda=400} e(\lambda) \cdot s(\lambda) \cdot \tau(\lambda) \cdot \Delta\lambda}, \quad \ldots. (1)$$

Where e (λ) is the spectral weighting function, s (λ) spectral irradiation for appropriate solar radiation, τ (λ) spectral transmittance through sample and Δ(λ) appropriate wavelength measuring interval. Various UPF rating details are given in Table 2.

Table 2. UPF Rating and Protection Category

Protection Category	UPF Range	Transmission (%)
Good	20 - 29	5.0 - 3.4
Very Good	30 - 40	3.3 - 2.5
Excellent	> 40	< 2.5

The fabric parameters ends per inch, picks per inch, areal density (g/m^2), thickness and air permeability are tested as per the procedures of ASTM D3775, ASTM D3776, ASTM D1777 and ASTM D737-04, respectively.

IV. RESULTS AND DISCUSSIONS

The UV protection properties of mostly influenced by the fibre polymer characteristics, yarn type, blend composition, fabric areal density, tightness factor of weave, finish, shrinkage, etc and also affects the UPF values. The measured values of UV transmittance %, UPF and air permeability are shown in Table 3.

Table 3. UV protection and Air permeability

Sample code	Details of Fibre Blend	Air Permeability ($cm^3/cm^2/s$)	Transmission %		UPF
			UV-A	UV-B	
BC1	Bamboo/Cotton (30:70)	119.5	17.5	10.3	8
BC3	Bamboo/Cotton (50:50)	118.5	15.9	8.1	10
BC3	Bamboo/Cotton (70:30)	118.4	14.8	6.4	10
BM1	Bamboo/Modal (30:70)	130.4	9.3	5.7	26
BM2	Bamboo/Modal (50:50)	132	6.2	2.1	32
BM3	Bamboo/Modal (70:30)	132.5	4.8	1.7	40
BP1	Bamboo/Polyester (30:70)	120	15.5	7.9	11
BP2	Bamboo/Polyester (50:50)	124.75	13.2	5.9	12
BP3	Bamboo/Polyester (70:30)	127.2	12.6	5.2	12

Though bamboo has got good UV protection properties, the blend fibre characteristics and proportion largely influence UV protection. It is apparently seen from Figure 1 that the blends of bamboo/cotton recorded significantly higher percentage of transmission of both UV-A and UV-B compared with bamboo/modal and bamboo/polyester blends. In spite of lower values of air permeability and presence of bamboo in its blend with cotton lower values of UPF are recorded in bamboo/cotton fabrics. This effect is due to the absence of double bond in the molecular structure of cotton. This shows the predominance of fibre structure in blocking UV.

It is also found that the polyester fibres, containing conjugated aromatic system, are effective in UV protection than cotton blends. The results of UPF values, UV-A and UV-B blocking show better performance.

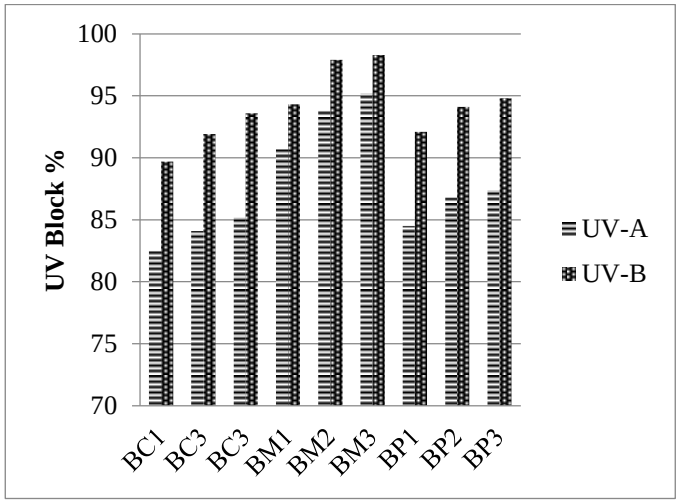

Figure 1. UV Blocking Percentage

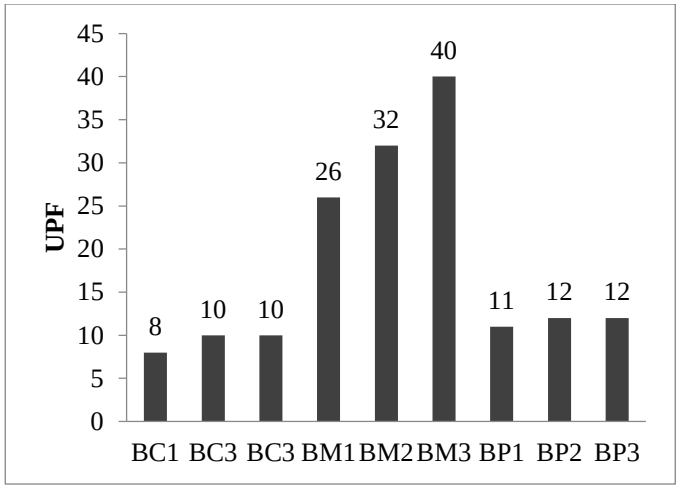

Figure 2. Ultra-violet Protection Factor

The transmittance of UV-A an UV-B in bamboo/modal blended fabrics decrease with increasing bamboo content. Comparatively, bamboo/modal (70:30) blended fabrics showed significantly higher values of UV protection against bamboo/cotton and bamboo/polyester fabrics in all the proportions. As per Table 2, UPF of more than 40 is considered to be excellent. The results are in agreement with the findings of Sudipta et al (14). The figure 2 clearly depicts that the UPF of bamboo/modal is far high compared to other blends.

V. CONCLUSIONS

- The increase in bamboo content causes an increase in UV protection proportionately.
- On comparison of UPF values of different blends with bamboo the effectiveness of UV protection is in the order cotton<polyester<modal.
- With respect to the proportion of blends higher bamboo with lower modal (70:30) recorded UPF value of 40 which is excellent as per scale.
- Hence, the bamboo/modal blend with 70:30 ratio can be successfully used as maternity wear without any harmful chemical finishes.

REFERENCES

[1]. Malik SK and Arora T,"UV radiations: Problems and remedies", Man-made textiles in India, 46(5) (2003) pp.164-169
[2]. Saravanan D, "UV protection of Textile Materials", AUTEX Res J, 7(1) (2007) pp.53-62
[3]. Achwal WB, "UV protection by Textiles", Colourage, 4 (2000), pp.50-51
[4]. Borradale D, Isenring E, Hacker E and Kimlin MG, "Exposure to solar ultraviolet radiation is associated with a decreased status in women of childbearing age", J Photochem Photobiol B, 131 (2014), pp.90-95
[5]. Hongying Yang, Sukang Zhu and Ning Pan, "Studying the mechanisms of titanium dioxide as ultraviolet-blocking additive for films and fabrics by an improved scheme", J applied polymer science, 92 (2004), pp.3201-3210
[6]. Sekar N, "UV absorbers in Textiles", Colourage, 11 (2000), pp.27-28
[7]. El Zaher NA and Kishk SS, "Study of the effect of UVR on the chemical structure, mechanical properties and crystallinity of Nylon-6 films", Colourage, 11 (1996), pp.25-30
[8]. Sharma DK and Singh M, "Effect of dyeing and finishing treatments on sun protection of woven fabrics- A study", Colourage Annual (2001), pp.69-74
[9]. Sharma V, "Bamboo fiber versus Cotton fiber: A comparative study", Man-made textiles in India, 39(9) (2011) pp.313-318
[10]. Sheshachala D, Sandeep D.N, Santosh S and Chetan Hosur, "Comparative study of bamboo and cotton knitted fabric", Man-made textiles in India, 51(9) (2008) pp.300-303
[11]. Singh MK and Annika Singh, "Ultraviolet protection by Fabric Engineering", J of Tex, (2013) pp.1-6
[12]. Jayalakshmi and Soundanya, "A study on the impact of bamboo material using natural dyes", Man-made textiles in India, 43(12) (2015) pp.464-472
[13]. Kan CW, "A study on ultraviolet protection of 100% cotton knitted fabric: Effect of fabric parameters", The scientific world journal, (2014), pp. 1-10
[14]. Sudipta SM, Patra AK and Thakur R, "Functional properties of bamboo/polyester blended knitted apparel fabrics", Ind J of Fibre& Tex Res, 37 (2012) pp. 231-237.