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Moisture Management Properties of Bamboo/cotton Knitted Fabrics

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Abstract: Effect of bamboo/cotton blend ratio on the moisture management properties of single jersey knitted fabrics has been studied. Moisture management properties have been considered and correlated to the blend ratio of bamboo/cotton yarn single jersey knitted fabrics. It is observed that as the bamboo content increases, the wetting time, maximum wetted radius increases rate of but spreading speed decreased and overall moisture management capacity decreased rate of absorption increased.
Keywords*: Bamboo, Blend ratio, Cotton, Knitted fabrics, Moisture Management*

I. INTRODUCTION

Moisture management property is an important aspect of any fabric meant for apparels, which decides the comfort level of that fabric. The ability to control the movement of moisture is called moisture management of textile material [1-2]. Moisture management is a co-aspect of a textile's properties that always needs to be regarded in tandem with comfort. The liquid moisture management performance of fabrics results from complex properties including their absorbent capacity, absorption rate, and evaporation [3].

Bamboo fabric absorbs and evaporates sweat very easily hence it gives comfortable feel. The morphological structure, IR, fibre orientation and breaking strength of bamboo fibre were investigated by Lipp-Symonowicz [4-5]. Prakash et al.[6] observed that quality characteristics of the blended yarn depend upon the bamboo content in the blend. Bamboo blended with cotton is usually 50/50 combinations [7].Prakash et al.[8-10] found in general that the thermal conductivity, thermal resistance, air permeability and relative water-vapour permeability values of the fabrics depend on bamboo fibre content in the fabric and the linear density of the constituent yarns. Wiah Wardiningsih et al. [11] studied the moisture transport responses to plain jersey fabrics produced from bamboo yarns. It was observed that as the cover factor of the fabric increased, the wetting time increased, maximum wetted radius decreased, rate of absorption decreased, spreading speed decreased and overall moisture management capacity decreased. The present study aims to investigate the liquid moisture management properties of bamboo/cotton knitted fabrics in relation with different blend ratios.

II. MATERIALS AND METHODS

Besides preparing 100% bamboo and 100% cotton yarns, blended yarn of blend proportion 50:50 were also prepared for the study. It should be emphasized that the bamboo fibres are the cellulose fibres manufactured from bamboo pulp. It was ensured that all of the yarns produced had the same mean linear density of 20^s Ne_c. The above yarns were used to produce single jersey fabrics on Meyer and Cie knitting machine. Samples were produced with same loop-length value of 3.3 mm fabrics respectively. The knitting process was completed with constant machine settings and the samples were kept in standard atmosphere for 24 hours to allow for relaxation and conditioning. The samples were scoured at 40 °C for 30 min using synthetic detergent, followed by rinsing for the same time period. After the scouring process was completed, the samples were dried.

III. TESTING

For dimensional properties, the number of wales and courses per inch were measured. The number of wales and courses per inch were determined by taking 10 measurements from different areas of each fabric. Mean values were calculated. Fabric thickness was measured on SDL digital thickness gauge according to ISO 5084 standard. The physical properties of the fabrics, such as thickness (mm) and weight per unit area (g/m^2) are given in Table 1. The moisture management properties of the bamboo/cotton blended yarn knitted fabrics were evaluated using Moisture Management Tester (MMT) from Atlas, which contained upper and lower concentric moisture sensors, enclosing the knitted sample [12-16]. Based on the signal we measured, a set of indexes is calculated, the descriptions of which are summarized by Hu et al[14]. According to AATCC Test Method 195-2009, the indices are graded and converted from value to grade based on a five grade scale.

TABLE I
Physical properties of bamboo/cotton blended yarn knitted fabrics

	Blend	Thickness (mm)	Mass per square meter (g/m^2)
1	100% Cotton	0.855	121.0
2	50:50 Cotton:Bamboo	0.739	99.7
3	100% Bamboo	0.640	82.0

TABLE 2
Moisture Management Test results of bamboo/cotton blended yarn knitted fabrics in value and grade

Blend ratio	WT_t (sec)	WT_b (sec)	AR_t (%/sec)	AR_b (%/sec)	MWR_t (mm)	MWR_b (mm)	SS_t (mm/sec)	SS_b (mm/sec)	R (%)	OMMC
100 % Cotton	3.73 (4)	3.98 (4)	47.22 (3)	48.783 (3)	21 (4)	23 (4)	4.32 (5)	3.99 (4)	178.122 (3)	0.473 (3)
50 % Cotton : 50 % Bamboo	3.322 (4)	3.66 (4)	48.91 (3)	49.608 (3)	18 (3)	19 (4)	3.31 (4)	3.01 (4)	46.111 (2)	0.421 (3)
100 % Bamboo	2.33 (5)	2.511 (5)	49.69 (3)	49.83 (3)	16 (3)	16 (3)	2.44 (3)	2.31 (3)	-48.061 (2)	0.372 (2)

IV. RESULTS AND DISCUSSION

A. Fabric Physical Properties

The selected fabrics have course per inch-38.5 and wales per inch-52.3. There is insignificant difference found among these fabrics as far as these geometrical characteristics concern. It may be gleaned from the data in table 1 that fabric thickness and fabric weight show a decreasing trend with increase in bamboo fibre content in the fabric, for all the fabrics investigated. These observations are substantiated by the findings of authors [8-10], who found that for yarns with the same linear density, the yarn diameter decreases as the proportion of bamboo fibre increases.

B. Wetting Time

The wetting time values of the top and bottom surfaces of the fabrics are given in Table 2. WT_t and WT_b are, respectively, the time periods in which the top and bottom surfaces of the tested fabric begin to wet after the commencement of the test [12]. As it can be seen from Table 2, the wetting time changes according to the blend ratio on the top and bottom surfaces. The results indicate that generally wetting time of the bottom surfaces is higher than the top surfaces for all the fabrics as expected. In the scope of this explanation, it can be stated that, the wetting time value is related with the water absorbency of the bamboo blended fabrics. From table 2 it can be seen that bamboo, cotton and bamboo/cotton blended fabrics, both 100% bamboo fabric has the very fastest wetting time in both top and bottom surfaces. As it can be seen from the table 2, as the percentage of bamboo fibre content increases above 50% the fabric wetting time grade increases from 4 to 5 (fast to very fast grade). It can be stated that the bamboo content increases in the fabric, the lower the wetting time is. As the bamboo content get increase, the thickness of the fabric decreases. Nilgun ozdil et al [17] stated that thinner fabrics have shown faster wetting than thicker ones, when equal amounts of water are applied. Abhijit Majumdar et al. [18] studied the thickness and mass per square meter of fabrics made from bamboo fibre blended yarns are generally lower than those of the fabrics made from cotton yarns with same linear density. Moreover, as the bamboo blended yarns have lower bending rigidity, the knitted loops can be compressed easily thereby reducing the fabrics thickness [10]. This lead to the lower the wetting time of the bamboo knitted fabrics.

C. Absorption Rate

The absorption rates of the top and bottom surfaces of the bamboo blended fabrics are given in table 2. As it can be seen from the table 2, the absorption rate values change according to blend ratios. The absorption rate is the average moisture absorption ability (%/sec) of the top and bottom surfaces of the fabric in the pulp time (20 sec). Because of the same reasons as explained for the wetting times of the fabrics, as the bamboo content gets increases, the thickness of the fabric decreases. Therefore the absorption

rate values of the thinner fabrics become higher. According to table 2, the bottom absorption rates of the fabrics are generally higher than top surfaces. This indicates that the most of the liquid moisture was distributed on the bottom surface of the fabric.

D. Spreading speed

Spreading speed test results are given in table 2. Wiah Wardiningsih et al. [11] studied that spreading speed of the bamboo fabrics reduced due to the low porosity. Abhijit Majumdar et al. [18] studied that the proportion of bamboo fibre increases, the porosity of the fabric reduces. As the spreading speed values are compared, it can be clearly seen that from table 2, the bamboo content increases, lower the spreading speed is. When the fabrics are thinner, the wetting time decreases as mentioned before, consequently spreading speed for the wetting of the thicker fabric are higher compared to the thinner fabric. This is probably also caused by low porosity value of bamboo fabrics.

E. Maximum Wetted Radius

In the study, maximum wetted radius of the fabrics wetted with the same amount of liquid is also investigated. Maximum wetted radius results of all the fabrics are also given in table 2.

According to maximum wetted results, it can be seen that the value decreases for the fabrics made from yarns having higher bamboo content. The MWR values are lower in bamboo-containing fabrics, as they are compared with the entirely cotton fabric. Because of the hydrophilic character of both cotton and bamboo fibre, some of the test liquid is absorbed by the fibers and penetrates into the fiber structure, which results in lower moisture spreading along the fabric. In the test equipment the top surface of the fabric is designed as inner surface that will be in touch with the human skin. Therefore, lower top MWR means lower wet touch, lower chilly feeling, and higher skin comfort. Since the bamboo fabrics have the lowest top wetted radius value, which also indicates its good moisture transport property, it will give a dry feeling.

F. Accumulative One-Way Transport Index And Overall Moisture Management Capability

Table 2 shows the values of Accumulative One-Way Transport Index (AOTI) and Overall moisture management capacity (OMMC) and the values are compared with the grading scale [12]. According to the results, it can be stated that bamboo fabric having low OMMC value. This may be due to minimum thickness of the bamboo fabric as compared to the other bamboo blended yarn fabrics. Most of the fabrics have a shorter top wetting time than bottom wetting time and all of the fabrics demonstrate higher absorption ability on the top surface than on the bottom surface. Fabrics have a negative accumulative one-way transport index, indicating that water solution content on the top surface is higher than on the bottom surface.

V. CONCLUSION

Blending has an important role in moisture related comfort properties of clothing. This study work mainly focuses on the effect of blend ratio on the moisture management properties of the bamboo/cotton blended yarn knitted fabrics. According to the results, it can be stated that, as the bamboo content increases, maximum absorption rate increase whereas the wetting time, maximum wetted radius, spreading speed and overall moisture management of the fabrics decreases. The blend ratio and fabric thickness influence the moisture management properties significantly. It was concluded that as blend ratio increases, the wetting time and maximum wetted radius decreases. It means that with the increase in blend ratio, it takes less time to wet a knitted fabric.

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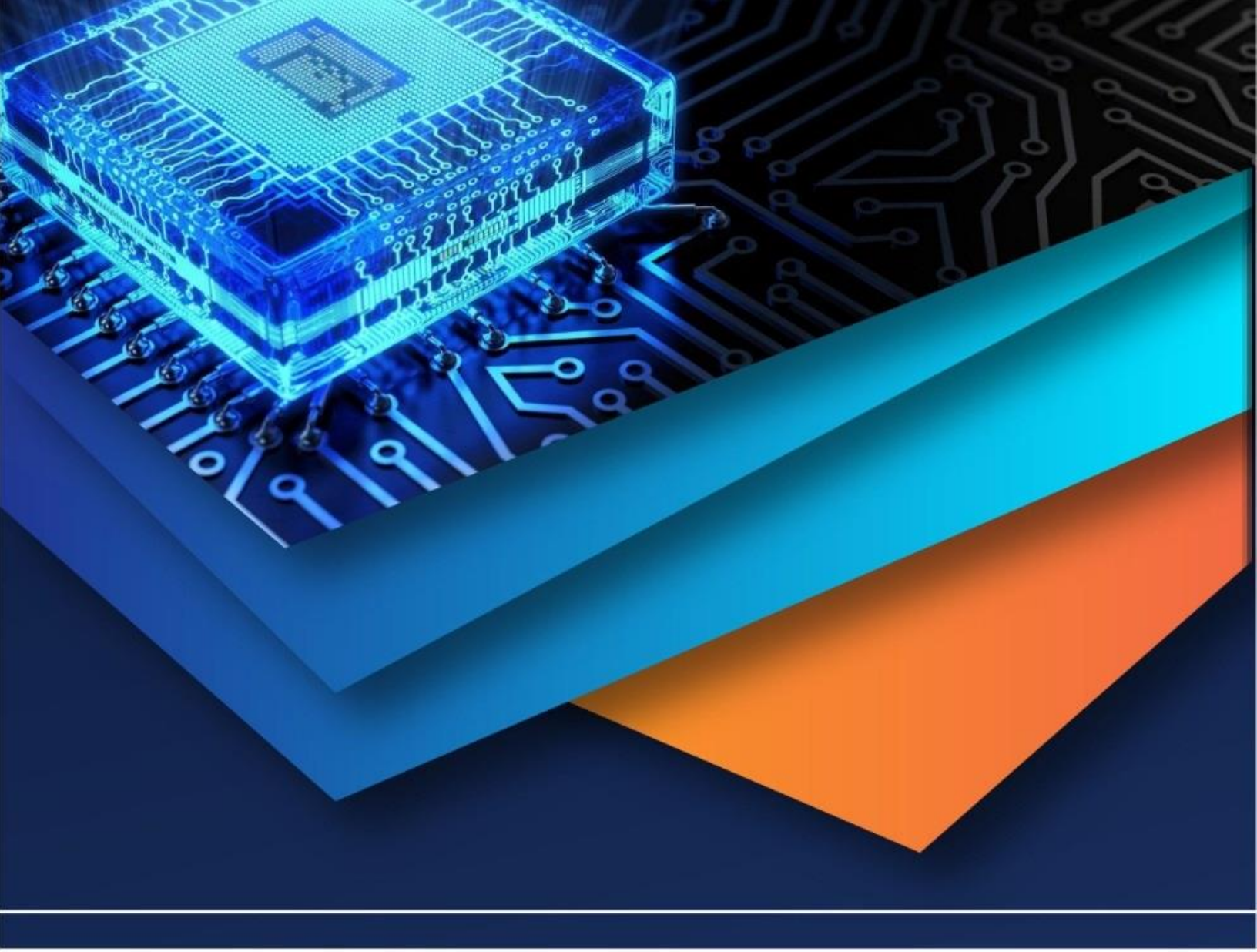

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