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Influence of Plasma Treatment and Weave Structure on Comfort Properties of Bamboo/Cotton Fabrics

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Abstract: *This research work aims towards study of Influence of weave structure on comfort properties of plasma treated woven fabrics made from three blend ratio of 100% bamboo,100%cotton and 50:50 bamboo and cotton will be used to spin 40s Ne Ring spun yarn. The developed yarns have been used to develop woven fabric of two different structures namely Plain and Twill weave. The developed fabrics have been treated with plasma using oxygen gas. The influence of plasma treatment and woven structure on comfort properties such as water vapour permeability, air permeability and thermal resistance. The tested result will be critically analyzed.*

Keywords: *Bamboo, Cotton, Woven fabrics, Plasma treatment, Comfort properties.*

1. INTRODUCTION

The Bamboo fiber have natural functions of anti-bacteria, bacteriostasis and deodorization .Even bamboo fiber samples still possesses excellent function of anti-bacteria, bacteriostasis. Its test result shows over 70% death rate after bacteria being incubated on bamboo fiber samples. Bamboo fiber's natural anti-bacteria function differs greatly from that of chemical anti-microbial. More important, bamboo fiber is a unique biodegradable textile material. As a natural cellulose fiber it can be 100% biodegraded in soil by micro organisms and sunshine. The decomposition process does not cause any pollution in the environment.

Cotton is a soft, fluffy staple fiber that grows in a boll, or protective case, around the seeds of cotton plants. The fiber is most often spun into yarn or thread and used to make a soft, breathable textile. The fiber of a thousand faces and almost as many uses, cotton is noted for its versatility, appearance, performance and above all, its natural comfort. From cotton fiber all types of apparel and technical textiles.

Plasma treatments are gaining popularity in the textile industry. Plasma surface treatments show distinct advantages, because they are able to change the surface layers, surface layer structure and physical properties of surface layers. Plasma, as a very reactive material, can be used to modify the surface of a certain substrate typically known as plasma activation or plasma modification. Recent development in the plasma treatment of textile materials has revealed that it has an enormous potential as an alternate technology for the textile processing in terms of cost saving, water saving and eco friendliness.

2. Materials and Methods

The bamboo and cotton yarns were spun on a miniature ring frame with 22.57 twists per inch. Table 2.1 shows the properties of bamboo and cotton spun yarns. The fabrics were woven from 40s count warp and weft, bamboo and cotton yarns on a miniature

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weaving machine. The construction details of woven fabric were 80 ends per inch and 76 picks per inch for woven plain and twill fabric.

Table 2.1 Fibre material properties

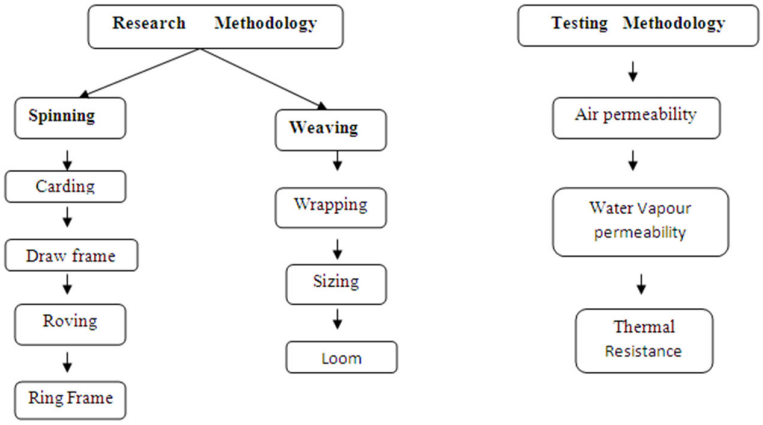
Sl no	Material properties	Bamboo	Cotton
1	Fibre length	38mm	32mm
2	Fibre denier	1.2 denier	2.0 denier
3	Fibre strength	34.3 g/tex	28 g/tex
4	Fibre elongation	20%	10%

Table 2.2 Fibre blends ratios

Sl no	Fibres	Blending Ratios
1	Bamboo	100%
2	Cotton	100%
3	Bamboo/ Cotton	50%:50%
4	Bamboo/ Cotton	70%:30%
5	Bamboo/ Cotton	30%:70 %

2.1. Methods

The methods of consist of Research Methodology and Testing Methodology. There are two processes namely spinning for the development of bamboo/cotton yarn and weaving for the development of plain and twill structure of bamboo/cotton fabric. The following flow chart structure shown the below Research and Testing methodology.



The Bamboo and Cotton fiber, which are used for this work, properties have been studied using standard testing method using appropriate testing instrument as shown in table 2.3.

Table 2.3 Fibre Properties Testing Method

Sl.no	Fibre properties	Instrument for testing	Standard
1.	Length	Hand stapling method	ASTM D5103 - 07(2012)
2.	Strength	Stelometer	ASTM D1445 / D1445M - 12
3.	Elongation	Stelometer	ASTM D1445 / D1445M – 12
4.	Fineness	Micronaire instrument	ASTM, D1445

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The Bamboo and Cotton yarn, which are used for this work, properties have been studied using standard testing method using appropriate testing instrument as shown in table 2.4.

Table 2.4 Yarn Properties Testing Method

Sl.no	Yarn Properties	Instrument for testing	Standard
1.	Yarn strength	Electronic Count Balance	ISO/TC 38/SC 23, British Standard No:1947(1970)
2.	Yarn elongation	tensile strength tester	ASTM D-5034:1995
3.	Yarn evenness	tensile strength tester	ASTM D2256, ISO 2062
4.	Yarn hairiness	Evenness tester	ASTM D1425 – 14
5.	Yarn imperfection	Shirley yarn hairiness tester	ASTM D5647 - 07(2012)
6.	Yarn imperfection	HVI, AFIS, Uster evenness tester	ASTM D1772
7.	Yarn friction	Instron tensile tester.	ASTM D3412 / D3412M - 13

The Bamboo and Cotton fabric, which are used for this work, properties have been studied using standard testing method using appropriate testing instrument as shown in table 2.5.

Table 2.5 Fabric Geometrical properties Testing Method

Sl.no	Fabric properties	Instrument for testing
1.	EPI	Manual
2.	PPI	Manual
3.	Cover Factor (EPIxPPI)	Manual
4.	Fabric GSM	Micro balance

The Bamboo and Cotton comfort properties fabric, which are used for this work, properties have been studied using standard testing method using appropriate testing instrument as shown in table 2.6.

Table 2.6 Fabric Comfort properties Testing Method

Sl.no	Fabric comfort properties	Instruments	Standards
1.	Air permeability	Air-tronic permeability tester	ASTM D737,ASTM D3574
2.	Thermal resistance	Permetester	ISO 11092
3.	Water vapour permeability	water vapour permeability tester using cup method	BS7209,BS3424

The Bamboo and Cotton fabric of geometrical details, which are used for this work, properties have been studied using standard testing method using appropriate testing instrument as shown in table 2.7.

Table 2.7 Fabric Geometrical Details

1	Cotton	40s
2	EPI	80
3	PPI	76
4	Cover factor	19.23
5	Thickness	0.36 mm

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3. Result and Discussion

Six varieties of woven samples were developed and tested their properties such as Water vapour permeability, Air permeability, thermal resistance and spray rating and their quality analysis are given below.

3.1 Water Vapour Permeability (g/m2/day)

The fabrics with hydrophilic components change their properties under different humidity conditions. The human body cools itself by sweat production and evaporation during period of high activity. The purpose of this study was to measure the water vapour permeability and evaporative resistance. The clothing must be able to remove this moisture in order to maintain comfort and reduce the degradation of thermal insulation caused by moisture build-up. The water vapour transmission rate (WVTR) was measured using the ASTM. As per BS7209 test method, the vapour permeability tests were carried out for six varieties of woven developed samples. Fig 1 shows the test result of water vapour permeability for all the developed woven fabric samples.

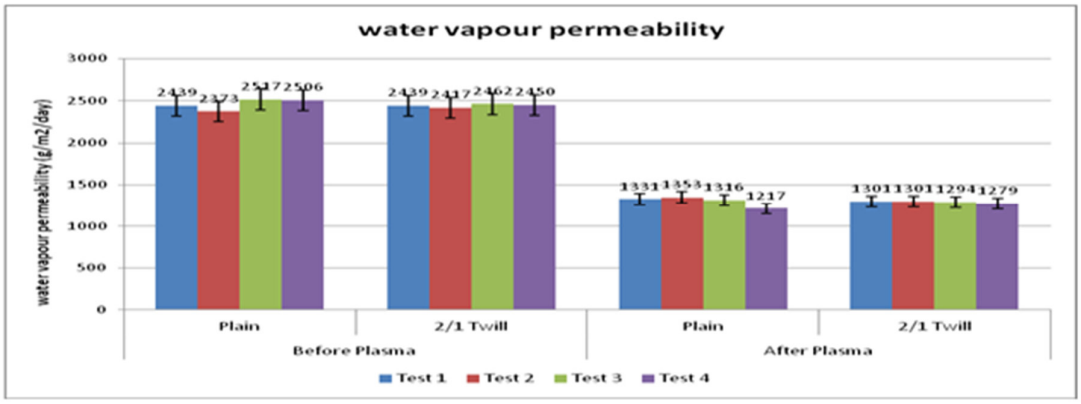

Fig 1 - Water Vapour Permeability of plain and twill woven fabric

The water vapour permeability in general was bamboo 100% is shown 4243 g/m2/day is higher than other woven samples. Where before plasma treated fabric both plain & twill bamboo: cotton 50:50 gives more water vapour permeability 2458.744 g/m2/day & 2442.112 g/m2/day. Then plasma treated fabric show lower water vapour permeability 1317.613 g/m2/day & 1293.589 g/m2/day. Hence the water vapour permeability gives higher vapour permeability fabric value give more comfort properties. The water vapour permeability data were statistically analyzed using t-test. It clearly indicated that the values were significantly different.

3.2 Air Permeability l/min/20cm2

As per ASTM D 737 test methods, air permeability test was carried out all six woven developed sample. The air permeability of a fabric is a measure of how well it allows the passage of air through it. The below shown figure the air permeability of tested fabric result.

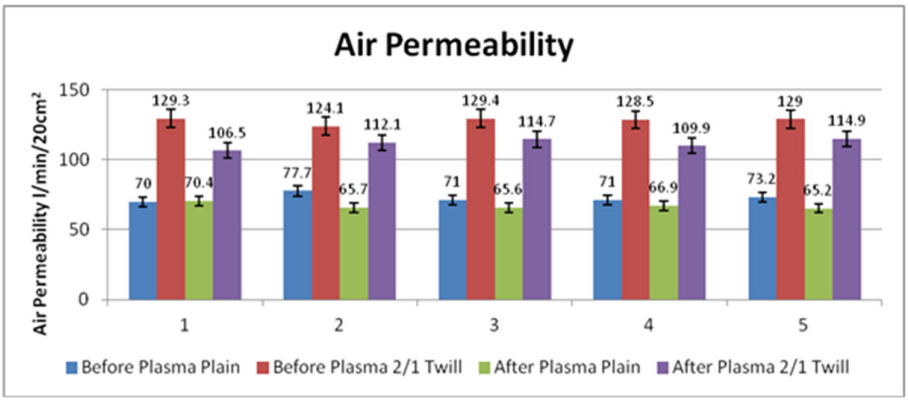

Fig 2- Air Permeability of plain and twill woven fabric

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The Air permeability result shows the 100% bamboo has 278 l/min/20cm2 is higher air allows to passage through fabric compared to without plasma treated fabric the plain 72.58 l/min/20cm2 & twill 128.06 l/min/20cm2. When after treated with plasma gas the plain fabric is 66.76 l/min/20cm2 and twill is 111.62 l/min/20cm2 .Further the air permeability found the 100% bamboo and cotton shows higher value. The air permeability data were statistically analyzed using t-test. It clearly indicated that the values were significantly different.

3.3 Thermal Resistance (Rct)m2.mk/w

Thermal resistance is a measure of a material's ability to prevent heat from flowing through it. Under certain climatic conditions, if the thermal resistance of clothing is low, heat energy will tend to gradually decrease, giving rise to a cool feeling. Thermal resistance is a very important parameter and is greatly influenced by fabric structure. Increase in fabric thickness will result in increase in thermal insulation, as there will be a decrease in heat losses for the space insulated by the textile. Thermal resistance is a function of the thickness and thermal conductivity of a fabric. In fact the general expectation was to observe an inverse relationship between thermal conductivity and thermal resistance.

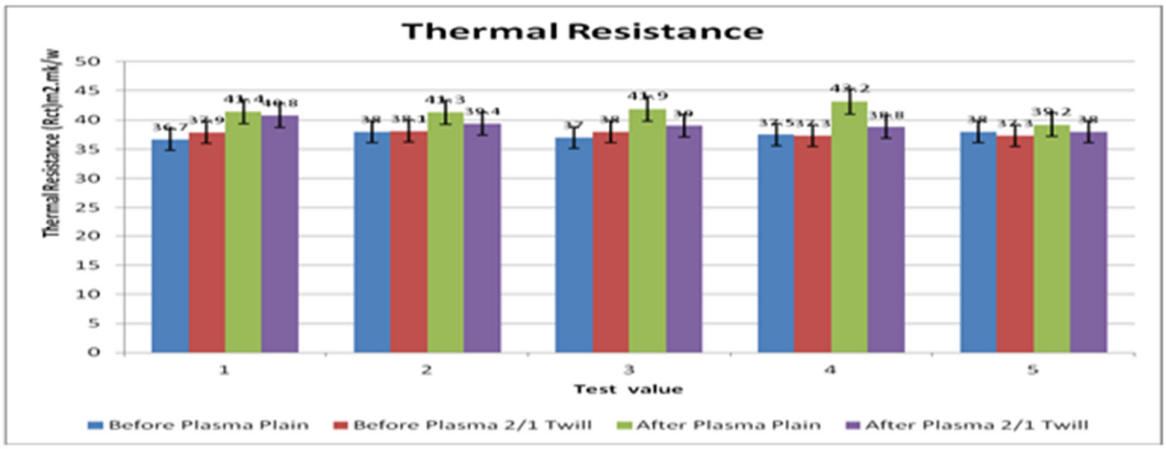

Fig-3 Thermal Resistance of Plain and Twill woven fabric

The thermal resistance tested six woven fabric shows the thermal resistance value of 100% cotton fabric is significantly higher than the blended materials showed that as the proportion of bamboo fibre in the yarn the thermal resistance of the fabric decreases . When compared before plasma treated fabric 37.44 m2.mk/w the plasma treated fabric shows 41.4 m2.mk/w is higher value. The thermal resistance data were statistically analyzed using t-test. It clearly indicated that the values were significantly different

The Bamboo and Cotton fabric of average testing result of comfort properties such as water vapour permeability, air permeability and thermal resistance as shown in table 3.1.

Table 3.1 bamboo/cotton woven fabric Testing Result

Sl.no	Description	Before Plasma		After Plasma	
		Plain	2/1 Twill	Plain	2/1 Twill
1	Water Vapour permeability Wvp(g/m^2/day)	2458.744	2442.112	1317.613	1293.589
2	Water Vapour permeability Index(L)	101.72	101.03	54.51	53.51
3	Air permeability I/min/20 cm^2	72.58	128.06	66.76	111.62
4	Thermal Resistance (Rct) m^2mk/w	37.44	37.72	41.4	39.2

4. Conclusion

The six varieties of woven structure of fabric plain and twill were produced using rapier weaving machine. The six varieties of fabrics were tested comfort properties such as Water vapour permeability, Air permeability and Thermal resistance and the results were critically analyzed. It was observed the plain100% bamboo fabric have showed better water vapour permeability and air permeability

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than other fabric due to blended proportion. The thermal resistance value of 100% cotton fabric is significantly higher than the blended materials showed fabric value give more comfort properties.

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