A STUDY ON COMFORT PROPERTIES OF VETIVER EXTRACT TREATED AND UNTREATED FABRIC

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ABSTRACT

In this endeavor, the comfort properties of plain woven cotton fabric and vetiver extract coated cotton fabric were analyzed and compared. The comfort properties such as thermal conductivity, thermal resistance, and water vapor permeability, air permeability, wicking and wetting properties were found for both fabrics. The results shown that both the fabrics have minor difference in values, that is the vetiver extract coated fabric has more comfort properties than the plain cotton fabric.

INTRODUCTION

Clothing comfort has been well known as one of the key main parameters considered by customers while wearing clothes[1]. In this high competitive and modern era, one of the major demands for the garment manufacturers is to satisfy the consumers. In this connection, the comfort plays the vital role in making the consumers to buy the product.

Comfort may be defined as a unbiased state in which a human being cannot get any ache or discomfort[2]. A study has found that even though the wearers consider fit, design, fashion, color, finishing and work in the cloth as important, but the most demanding and satisfying one person is the way the garment gives feel while wearing it[3]. By touching the fabric, we can feel various vibrations like smoothness, roughness, prickliness, pickiness, stickiness, scratchiness, softness stiffness, warmness, coolness, weight[4,5].

Vetiver (Chrysopogon zizanioides, previously Vetiveria zizanioides), a member of the family Poaceae commonly known as the Khas- Khas, Khas or Khus grass in India, is a perennial grass with thick roots which are aromatic and highly valued. This plant has chosen for the research due to its antimicrobial, high tensile property filled with inherent aroma[6].

MATERIALS AND METHODS

VETIVER EXTRACT PREPARATION

Vetiver roots were bought from local organic shop, Coimbatore. Its roots were finely slashed and converted as powder. This powder has been converted into vetiver liquid by using Soxhlet hot extraction process with the help of ethanol. The prepared solution was kept untouched for about 6 hours and used for further purpose[7,8,9].

FABRIC PREPARATION

The woven cotton untreated fabric with 60s Ne was chosen and the plain fabric was undergone desizing, scouring and bleaching process for further usage.

The fabric was desized with 2% of dilute hydrochloric acid for a period of one hour at a temperature of 50^{o}C. Then, the fabric was rinsed thoroughly in cold water. Scouring was carried out by adding 7% of sodium hydroxide , 1% of wetting agent and 2% of sodium silicate at 60°C for 1 hour. Then the fabric was rinsed and dried thoroughly. Bleaching was carried out by treating the fabric with 7% hydrogen peroxide, 2% sodium silicate, 1% soda ash and 0.6% sodium hydroxide solution and treated at 90^{o}C for 1 hour. Then the fabric was rinsed and dried thoroughly.

VETIVER EXTRACT COATING ON FABRIC

The prepared vetiver solution was coated on the plain cotton fabric with the help of pomegranate mordant by using pad-dry-cure technique[10]. The fabric was passed into the extract solution under a submerged roller and taken out of the bath. The process was repeated for 3-4 times. Then the fabric was squeezed and dried.

COMFORT PROPERTY TESTINGS

The untreated and vetiver extract treated cotton fabric was subjected to assess the comfort properties such as thermal conductivity, thermal resistance, air permeability, water vapour permeability, wickability and wettability based on the standard test procedures[11,12].

THERMAL CONDUCTIVITY

The ability to transfer heat from the untreated and vetiver extract treated cotton fabric were identified using Lee's disc method according to ASTM D 6343 standard test method.

The untreated and vetiver extract treated cotton samples were cut using the template. The mass of the brass disc was measured using a balance and take it as *m* kg. The diameter was measured and hence the radius of the sample was identified. Calculate the circular area of the disc, $A = \pi r^2$. The thickness of the sample was measured using a screw gauge and take it as *d*. The thermometers were inserted in the metallic and brass disc. The heating chamber was then placed on the above assembly and suspended. The heater was started, by sending steam through the heating chamber. The temperatures T_1 and T_2 at a regular interval were monitored till they reach the steady state. Then the steady state temperatures T_1 and T_2 were noted. The heating chamber was lifted and the sample was removed, then the heating chamber was directly allowed on the brass disc to heat about 10 ^{0}C above the steady state temperature T_2. Then the heating chamber was removed .Then the time taken for cooling was noted. By applying this temperature

(θ) and time taken for cooling the temperature(t) in the formula, the thermal conductivity value was calculated.

$$K = \frac{Msd(r+2l)(d\theta/dt)}{\pi r^2(2r+2l)(\theta_1 - \theta_2)} \text{ W/m/K } [13]$$

Figure 1: Thermal conductivity by Lee's disc

THERMAL RESISTANCE

The thermal resistance value was identified using permetester according to the ASTM standard D 1518 test procedure. It works on the heat flux sensing principle. Here the measuring head was heated to body temperature (33ºC-35ºC) and the room temperature was kept at 20ºC-22ºC. The output voltage was calculated with and without the sample. The dry thermal resistance of the sample is found by the difference between the heat flow with and without sample. The dry thermal resistance formula was given as follows:

$$R_t = (T_1 - T_0) \times \left(\frac{1}{S.u_1} - \frac{1}{S.u_0} \right)$$

Where R_t is the dry thermal resistance;

T_1 and T_0 are with and without the fabric sample temperatures;

μ_0 and μ_1 are the voltage outputs with and without the fabric sample;

S is the sensitivity of the instrument.

The ambient temperature was set at 22-25ºC & RH around 50-65%. The temperature T_0 was noted. The spacer ring from the measuring head was removed and the temperature of the measuring head was set to 35ºC with the help of the temperature controller. This temperature was noted as T_1. The voltage output was noted as u_0. The fabric sample was kept on the measuring head and the output value u_1 was noted. By applying these values on the formula, the thermal resistance value was calculated.

Figure 2:Permetester

WATER VAPOR PERMEABILITY

The transmission of water vapor to the outside environment was identified by water vapor permeability tester cup method according to the ASTM standard E 96 test procedure.

Both the untreated and vetiver extract treated cotton fabric were cut using the template. Each dish was filled with enough distilled water with a 10mm air gap between the water surface and the fabric. A wire sample support was placed on each dish to keep the fabric level. The rim of the dish and the specimen was applied with adhesive, was carefully placed on top with its outside surface uppermost. The cover ring was then placed over the dish and the gap between cover ring and dish sealed with PVC tape. Each dish was then weighed. All the dishes were then placed in the standard atmosphere and allowed to stand for 24 hours to establish equilibrium. After 24 hours, the dishes were taken and weighed again. The difference in the weight loss was noted as M. By substituting this value in the formula, the water vapour permeability was calculated[14].

Water vapour permeability (WVP)

$$\mathbf{WVP} = \frac{\mathbf{24^* M \quad g/m^2/ 24\ hrs}}{\mathbf{A\ ^*T}}$$

Where:

M is the mass difference (grams)

A is the area (m^2)

T is the time (hrs)

Figure 3:Water vapor permeability tester

AIR PERMEABILITY

Air permeability is measured as the volume of air in millilitres or litres/min or cm^3/cm^2 /sec, which is passed in one second through 100 mm^2 of the fabric at a pressure difference of 10mm head of water or 100 Pa pressure according to the ASTM D 737 standard.

The untreated fabric and vetiver extract treated fabric was cut using the template. The parameters such as pressure drop, measuring volume was set. The sample was then placed on the testing area and the vacuum was applied. By adjusting the knob to reach 10 Pascal on the display, the values were identified. By substituting these values in the formula, the air permeability was calculated[15].

Air permeability $R = \frac{r \times 1000}{60 \times 60 \times A}$ $cc/sec/cm^2$

where, r - rotometer value (lit)

A- area of the ring (cm^2)

Figure 4: Air permeability tester

WICKABILITY

Wickablility is defined as the ability of a material to not only absorb sweat but to actually move it away from our bodies. The wickability of the untreated cotton and vetiver extract treated cotton fabric was identified using wickability tester according to the ASTM standard D 2692.

The samples were cut with the size 2"x6" in both warp and weft direction. 5 lines were marked on the sample with 1 cm distance each. 50 ml of distilled water was mixed with a dye in beaker. The sample was clamped on the stand and suspended towards the beaker. The time taken to reach each cm was noted and thus the wickability value was calculated.

WETTABILITY

The wettability of the untreated cotton and vetiver extract treated cotton fabric was identified using spray rating tester according to ISO 139 standard test procedure.

The fabrics were cut with the size of 18x18cm. The sample was then placed on the specimen holder using cover ring. 250 ml of distilled water was poured through funnel on the fabric, and the sample was kept for 30 seconds. These fabrics were then compared with the grey scale and the wettability was calculated.

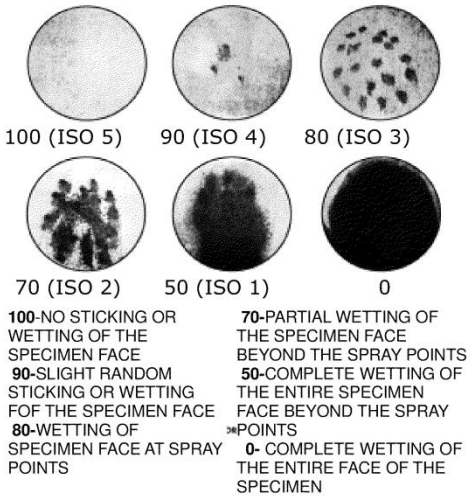

Figure 5: Spray rating tester and standard board

RESULTS AND DISCUSSION

The comfort properties such as thermal conductivity and resistance, air and water vapor permeability, wickability and wettability was observed for both untreated cotton and vetiver extract coated cotton fabric.

THERMAL CONDUCTIVITY AND RESISTANCE

The thermal conductivity and resistance of the untreated cotton and vetiver extract treated cotton fabric was analyzed and the values were shown in the table 1.

Table 1: Thermal conductivity and resistance of the fabric

S.no	**Thermal conductivity (w/m/k)**		**Thermal resistance (m^2.mk/w)**	
	Untreated fabric	**Vetiver extract treated fabric**	**Untreated fabric**	**Vetiver extract treated fabric**
1	0.0111	0.0181	90.09	55.24
2	0.0172	0.0152	58.13	65.78
3	0.0154	0.0176	64.93	56.81
4	0.0132	0.0192	75.75	52.08
5	0.0174	0.0214	57.47	46.72
Mean	**0.0148**	**0.0183**	**69.27**	**55.32**

STATISTICAL ANALYSIS- ONE WAY ANOVA

Anova: Single Factor

SUMMARY

Groups	*Count*	*Sum*	*Average*	*Variance*
0.0111	4	0.0632	0.0158	3.81E-06
0.0181	4	0.0734	0.01835	6.84E-06

ANOVA

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	1.3E-05	1	1.3E-05	2.442254	0.169135	5.987378
Within Groups	3.2E-05	6	5.33E-06			

Anova: Single Factor

SUMMARY

Groups	*Count*	*Sum*	*Average*	*Variance*
90.09	4	256.28	64.07	72.00187
55.24	4	221.39	55.3475	65.36209

ANOVA

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	152.164	1	152.164	2.215487	0.187202	5.987378
Within Groups	412.0919	6	68.68198			
Total	564.2559	7				
Total	4.5E-05	7				

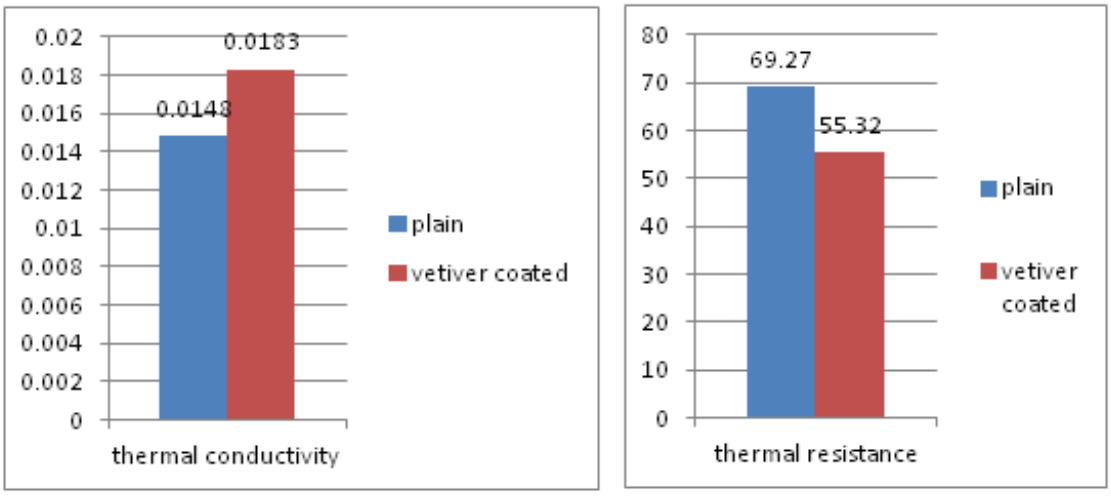

Figure 6: Thermal conductivity and thermal resistance

The test results revealed that the vetiver extract treated fabric has more thermal conductivity and less thermal resistance than the untreated fabric, results in more heat transmission in vetiver extract treated fabric than untreated cotton fabric. The statistical analysis results also proved the 5% significant difference between the untreated and treated fabric.

AIR PERMEABILITY

The air permeability for both untreated and vetiver extract treated fabric was analyzed and the results were interpreted in the table 2.

Table 2: Air permeability of the fabric

FABRIC	**Untreated cotton fabric (r value)**	**Air permeability (Untreated cotton fabric cc/sec/cm^2)**	**Vetiver extract coated cotton(r value)**	**Air permeability (treated cotton fabric cc/sec/cm^2)**
1	1930	134.02	1840	127.77
2	2160	150	2060	143.05
3	1840	127.77	1800	125
4	1780	123.61	1660	115.27
5	1750	121.52	1700	118.05
Mean		**131.39**		**125.82**

STATISTICAL ANALYSIS- ONE WAY ANOVA

Anova: Single Factor

SUMMARY

Groups	*Count*	*Sum*	*Average*	*Variance*
134.02	4	522.9	130.725	171.871
127.77	4	501.37	125.3425	156.1029

ANOVA

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	57.94261	1	57.94261	0.353337	0.573945	5.987378
Within Groups	983.9216	6	163.9869			
Total	1041.864	7				

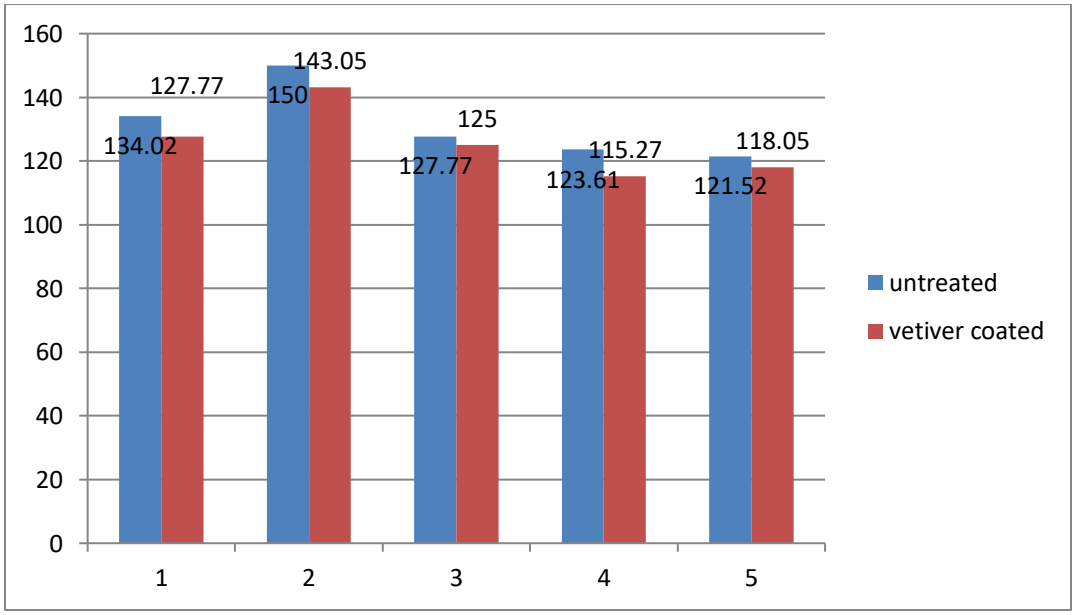

Figure 7: Air permeability for untreated and vetiver extract treated fabric

The results showed the minimum level of difference in the air permeability values between the vetiver extract coated cotton fabric and untreated cotton fabric. This is due to the deposition of molecules in the fabric structure.

WATER VAPOR PERMEABILITY

The water vapor permeability for both untreated cotton and vetiver extract coated cotton fabric was found and the results were shown in the table 3.

Table 3: Water vapor permeability of the fabric

S.no	**Untreated fabric**			**Vetiver extract treated fabric**		
	Initial weight (gm)	**Final weight (gm)**	**Weight loss (m)**	**Initial weight (gm)**	**Final weight (gm)**	**Weight loss (m)**
1	106.59	102.5	4.09	96.2	96.64	4.04
2	107.34	103.21	4.13	98.89	94.32	4.57
3	108	104.21	3.79	97.41	93.20	4.21
4	106.89	102.2	4.69	98.21	94.19	4.02
5	107.49	103.31	4.18	99.08	95.58	3.5
Mean			**4.176**			**4.068**
Water vapor permeability ($g/m^2/day$)		**7.91 ($g/m^2/day$)**		**7.71 ($g/m^2/day$)**		

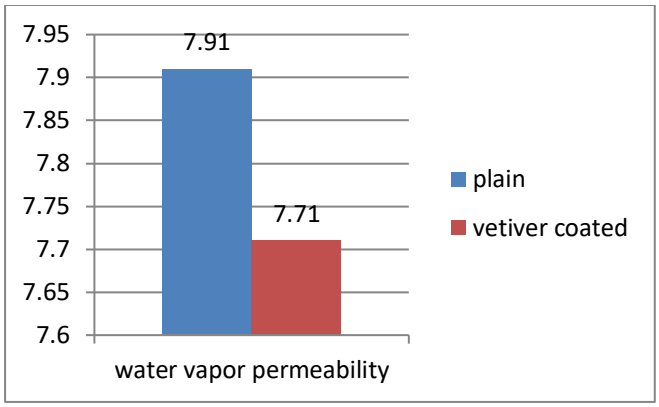

Figure 8: Water vapor permeability for untreated and vetiver extract treated fabric

There is a minor difference in the water vapor permeability values between the vetiver extract treated cotton fabric than untreated cotton fabric. This is due to the density of molecules in the vetiver extract.

WICKABILITY

The wicking test was done for both the untreated cotton and vetiver extract treated cotton fabric and the results were shown in the table 4.

Table 4: Wicking test for fabric

Height (cm)	**Untreated fabric (time in sec)**	**Vetiver extract coated fabric (time in sec)**
1	45	67
2	114	134
3	158	176
4	224	239
5	549	576

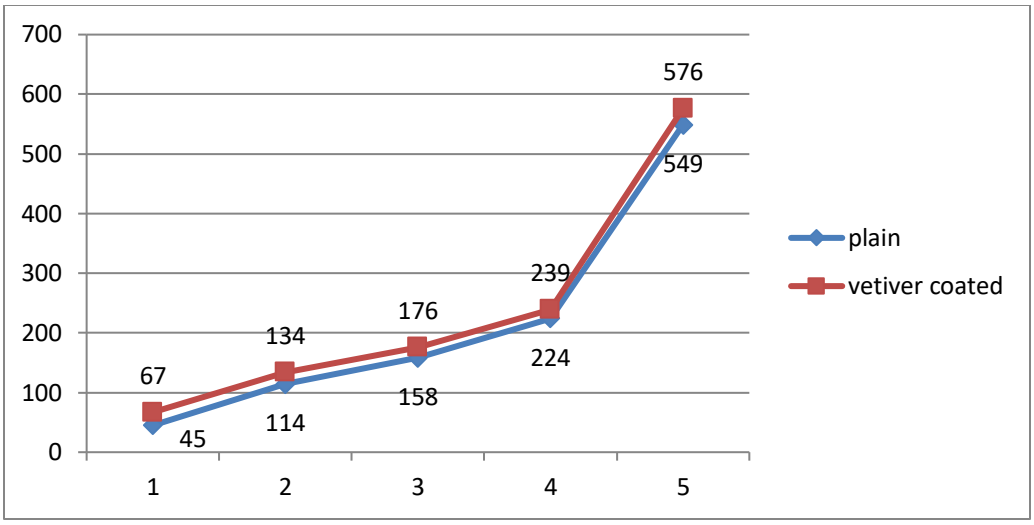

Figure 9: Wickability test of the fabric

The vetiver extract coated fabric showed less wicking property than the untreated fabric.

WETTABILITY

The wettability of the untreated cotton and vetiver extract treated cotton fabric was found using spray rating test and the test results were shown in the table 5.

Table 5: Wettability test results of the fabric

	PLAIN FABRIC	**VETIVER EXTRACT COATED FABRIC**
WETTABILITY	70 (ISO 2)	70 (ISO 2)

The results showed that both the fabric shows partial wetting of the specimen space beyond the spray points and hence observed that it has minimum absorbency capacity.

CONCLUSION

The comfort property test such as thermal conductivity and resistance showed that the vetiver extract treated fabric has more thermal conductivity and less thermal resistance than the untreated fabric, results in more heat transmission in vetiver extract treated fabric than untreated cotton fabric. The air and water vapor permeability results also showed the minimum level of difference in between the vetiver extract coated cotton fabric and untreated cotton fabric and less

wicking property in the coated fabric than the untreated fabric because of the deposition of molecules in the fabric structure.

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