ORIGINAL ARTICLE

Influence of banana pseudostem aqueous extract on the comfort properties of cotton fabric

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Abstract

Background: Pseudostem is a part of banana plant that looks like trunk which is formed by tightly overlapping leaf sheaths. The main aim of the study is to apply the pseudostem extract on the cotton fabric at varying pH level by pad-dry-cure method and evaluate the comfort properties of the fabric. **Materials and Methods:** The pseudostem extract was prepared in a grinder. The cotton fabric was treated with banana pseudostem aqueous extract by pad-dry-cure method. The pH of the solution is varied from 6 to 8 by keeping the temperature and time constant. The influence of pH on the comfort properties of the fabric such as air permeability, wickability, and thermal resistivity is studied. **Results and Discussion:** The fabric treated with pH 6.5 has given better comfort properties. The thermal resistivity of the fabric was improved by 9.24, 7.26, 6.49, and 4.46% than the samples treated with pH 6, 7, 7.5, and 8. No significant influence on fabric wickability and air permeability is found due to change in pH.

Key words: Air permeability, banana sap, cotton, pH, thermal resistivity

INTRODUCTION

In recent times, prime importance is given to the comfort properties of the textile materials due to the acceptability of a textile fabric largely depending on the comfort aspects which involve thermal properties, air permeability, and water vapor permeability.[1]

Comfort properties determine the way in which the heat, air, and water vapor are transmitted across the fabric. During heavy activities, the body produces lots of heat energy and the body temperature rises. To reduce the temperature, the body perspires in liquid and vapor form. When this perspiration is evaporated to the atmosphere, the body temperature reduces. Hence, the garments should allow the perspiration to pass through to ensure comfort. Therefore, thermal and water vapor transmission properties of fabrics are very important for the body comfort. Besides, the “warm-cool” feeling on the first brief contact of the fabric with the human skin is also a very important parameter that influences the comfort properties of textile fabrics.[2]

Thermal comfort properties of textile fabrics are actually influenced by the gamut of fiber, yarn, and fabric properties. The type of fiber, spinning technology, yarn count, yarn twist, yarn hairiness, fabric thickness, fabric cover factor, fabric porosity, and finish is some of the factors, which play a decisive role in determining the comfort properties of fabrics.[3]

Some researchers have also studied the effect of microdenier fiber on the comfort aspects of fabrics and reported that microdenier fibers give lower thermal conductivity and higher thermal resistance.[4] Oglakcioglu *et al*.[5] studied the thermal comfort properties of cotton-angora rabbit fiber blended rib-knitted fabrics and found that the mixing of angora fiber beyond 25% affected the thermal comfort properties significantly. Du *et al*.[6] demonstrated that the optimum porosity of uniform fibrous porous materials for the thermal insulation is very much dependent on the fiber emissivity and fiber radius.

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The thermal insulation functionality is also imparted to the textile materials by functional finishing of textile materials. Natural finishes such as antimicrobial finishes using neem, *Aloe vera*, and banana peel extract are gaining importance due to the awareness among the consumers about human health and hygiene.[7,8] Very few researchers have been worked on thermal insulation of cellulosic materials using banana extract. In the present research work, the effect of banana pseudostem extract on the comfort properties such as thermal resistivity, air permeability, and wickability of the cotton fabric was investigated.

MATERIALS AND METHODS

Collection of Banana Stem

Bleached cotton fabric was used for the study. The fabric particulars are given in Table 1. The banana pseudostem was collected from nearby fields in Coimbatore, Tamil Nadu, India.

Preparation of Pseudostem Extract

The banana pseudostem was rinsed in clean water. They were cut into small pieces and then mixed with small amount of water. It was ground well in mixer. The extract was collected by straining the mixer. The banana pseudostem extract was applied on cotton fabric using pad-dry-cure method at five different conditions which are given in Table 2.[9]

Application of Pseudostem Extract of Cotton Fabric

The banana pseudostem extract was tested to know the pH of the extract using digital pH meter. Calibration is performed with at least two standard buffer solutions. The pH of the banana pseudostem extract was found to be 6. NaOH was used to increase the pH level by 0.5, i.e., 6.5, 7, 7.5, and 8. The water bath is set with temperature 40°C. Banana pseudostem extract was taken in a beaker and the cotton fabric was immersed in the solution. The beaker was kept into the water bath and pH of the solution was maintained about 6. Similarly, the same procedure was followed for other samples by varying the pH from 6.5 to 8. The sample is treated for 45 min at 40°C. The sample was taken out from the beaker and squeezed to remove the excess solution and dried in the sunlight.

Testing of Fabric Samples

The comfort properties such as air permeability, wickability, and thermal conductivity were also determined as per standard procedure. The air permeability of fabrics was determined according to ASTM D737 using MAG Solvics air permeability tester. The rate of air permeability was measured using the following equation:

$$\text{Air permeability } [R] = \frac{r}{a} \text{ cm/s} \quad (1)$$

Where r = mean rate of flow of air in cm^3/s, a = area cm^2 of fabric under test.

The wicking height of the fabric was measured as per DIN 53924 using strip test method (Das *et al*., 2008). A fabric strip of 200 mm × 25 mm was suspended vertically with 30 mm of its lower end immersed in distilled water. The height reached by the water in the fabric was noted with respect to time at regular intervals.

The thermal resistance of the fabrics was tested using permi tester. The abrasion resistances of the fabrics were tested according to ASTM D 4966–98 Standard Test Method for Abrasion Resistance of Textile Fabrics - Martindale Abrasion Tester Method. The abrasion resistance was determined by the mass loss as the difference between the masses before and after abrasion cycles of 5000. These values were then expressed as a percentage of the initial mass.

RESULTS AND DISCUSSION

Air Permeability

Air permeability plays an important role in transporting moisture vapor from the skin to the outside atmosphere. The air permeability of a fabric is defined as the amount of air passed over a surface under a certain pressure difference in a unit time. The air permeability of fabric depends on the number and pore size through which most of the airflow permeates.

The air permeability of the banana pseudostem-treated fabrics is depicted in Figure 1. It is observed that the air permeability of the BPS2 sample is higher when compared to other samples. The lowest air permeability is found in the

Table 1: Geometrical parameters of the fabric

Fabric	Ends per inch	Picks per inch	Warp yarn count (Ne)	Weft yarn count (Ne)	Warp crimp (%)	Weft crimp (%)	Arial density (g/m²)	Cover factor
Plain fabric	94	72	23	20	8	10	105	25.3

BPS3 sample. The air permeability of the BPS2 sample is 9, 10.6, 9, and 6% greater than the samples BPS1, BPS3, BPS4, and BPS5 samples, respectively.

Wickability

Wicking is the spontaneous flow of a liquid in a porous substrate, driven by capillary forces. The flow of the liquid through any porous medium is due to the capillary action which is governed by the properties of the liquid, liquid-medium surface interactions, and geometric configurations of the pore structure in the medium.[10] Wicking occurs when a liquid travels along the surface of the fiber but is not absorbed into the fiber.

The wickability of the cotton fabric in warp and weft direction is given in Table 3. It is inferred from the results that the wickability in weft direction is better than warp direction due to the lower wicking time, whereas in warp direction, the wicking time is higher. Lower wicking time indicates the quicker water transportability. The higher wicking ability of the fabrics from coarser yarns may be partly a result of their higher thickness values, as the fabric thickness can provide more space to accommodate water, which can lead to more water transferred, depending on the capillary space available as well as the capillary pressure present (X). This is also due to the lower yarn density and coarser yarn used in the plain fabric. The fiber, yarn, and fabric properties influence the wickability of the fabric.

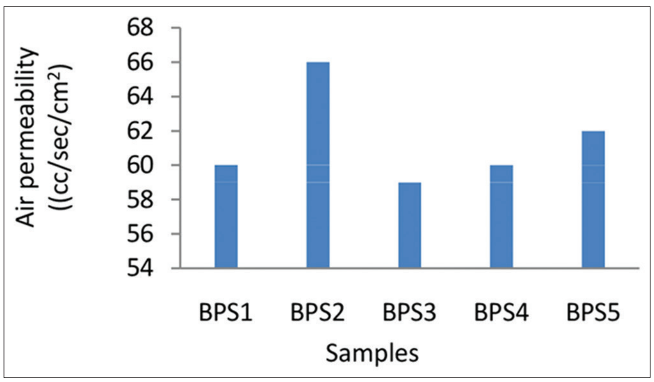

Figure 1: Air permeability of banana pseudostem extract-treated fabrics

Table 2: Treatment conditions of banana pseudostem extract on the fabric

Sample ID	pH	Temperature	Time (min)
BPS 1	6	40°C	45
BPS 2	6.5		
BPS 3	7		
BPS 4	7.5		
BPS 5	8		

Thermal Resistance

Thermal resistance is a measure of the body's ability to prevent heat from flowing through it. If the thermal resistance of clothing is small, the heat energy will gradually reduce with a sense of coolness under certain climatic conditions.[11-15]

Thermal resistivity of the banana pseudostem-treated fabric samples is given in Table 4. The sample BPS2 has shown greater thermal resistivity of 88.68, followed by 84.72, 82.92, 82.24, and 80.48 for BPS5, BPS4, BPS3, and BPS1, respectively. The thermal resistivity of BPS2 is 9.24, 7.26, 6.49, and 4.46% higher than the samples BPS1, BPS3, BPS4, and BPS5 samples, respectively. It is also found that the thermal resistivity of the BPS2 was 72.71% higher when compared to untreated fabric.

CONCLUSION

The influence of banana pseudostems extract on cotton fabric at different pH levels was studied on fabric comfort properties. It is found from the results that the fabric treated at pH 6.5 has shown better comfort properties rather than the fabric treated at pH 6, 7, 7.5, and 8. The fabric treated at pH 6.5 has given higher thermal resistance than other fabrics. There is no significant influence found on the air permeability and wickability of the fabrics.

Table 3: Wickability of banana pseudostem extract-treated fabrics

Direction	Warp direction (time in s)					Weft direction (time in s)				
Height in cm	1	2	3	4	5	1	2	3	4	5
BPS 1	20	37	52	70	89	17	34	50	65	78
BPS 2	22	37	54	74	92	19	32	48	60	74
BPS 3	22	34	56	75	85	16	32	48	66	75
BPS 4	24	36	48	65	78	17	29	40	58	69
BPS 5	22	37	54	72	86	17	32	48	62	72

Table 4: Thermal resistivity of the banana pseudostem-treated fabrics

Samples	Thermal resistivity
BPS 1	80.48
BPS 2	88.68
BPS 3	82.24
BPS 4	82.92
BPS 5	84.72

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REFERENCES

1. Oğlakcioğlu N, Marmarali A. Thermal comfort properties of some knitted structures. Fibres Text East Eur 2007;15:64-5.
2. Machova K, Klug P, Waldmann M, Hoffmann G, Cherif C. Determining of the bending strength of knitted spacer fabrics. Melliand Textil Int 2006;87:93.
3. Özdil N, Marmaralı A, Kretzschmar SD. Effect of yarn properties on thermal comfort of knitted fabrics. Int J Therm Sci 2007;46:1318-22.
4. Sampath MB, Senthilkumar M. Effect of moisture management finish on comfort characteristics of microdenier polyester knitted fabrics. J Ind Text 2009;39:163-73.
5. Oglakcioglu N, Celi P, Ute TB, Marmarali A, Kadoglu H. Thermal comfort properties of angora rabbit/cotton fiber blended knitted fabrics. Text Res J 2009;79:888-94.
6. Du N, Fan J, Wu H. Optimum porosity of fibrous porous materials for thermal insulation. Fibre Polym 2008;9:27-33.
7. Kumar GR, Krishnaveni V. Herbal antimicrobial finish on cotton fabric using *Aloe barbadensis* miller (*Aloe vera*). Asian Text J 2007;16:76-8.
8. Krishnaveni V, Rajkumar G, Shanmugam S. Antimicrobial finish on textiles. Colourage 2007;54:46-8.
9. Basak S, Samanta KK, Saxena S, Chattopadhyay SK, Narkar R, Mahangade R, *et al*. Flame resistant cellulosic substrate using banana pseudostem sap. Pol J Chem Technol 2015;17:123-33.
10. Sun D, Stylios GK. Effect of low temperature plasma treatment on the scouring and dyeing of natural fabrics. Text Res J 2004;74:751-6.
11. Majumdar A, Mukhopadhyay S, Yadav R. Thermal properties of knitted fabrics made from cotton and regenerated bamboo cellulosic fibres. Int J Therm Sci 2010;49:2042-8.
12. Bedek G, Salaün F, Martinkovska Z, Devaux E, Dupont D. Evaluation of thermal and moisture management properties on knitted fabrics and comparison with a physiological model in warm conditions. Appl Ergon 2011;42:792-800.
13. Sampath MB, Aruputharaj A, Senthilkumar M, Nalankilli G. Analysis of thermal comfort characteristics of moisture management finished knitted fabrics made from different yarns. J Ind Text 2012;42:19-33.
14. Rajkumar G, Srinivasan J, Suvitha L. Natural protein fiber hybrid composites: Effects of fiber content and fiber orientation on mechanical, thermal conductivity and water absorption properties. J Ind Text 2015;44:709-24.
15. Rajkumar G, Srinivasan J, Suvitha L. Development of novel silk/wool hybrid fibre polypropylene composites. Iran Polym J 2013;22:277-84.

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