ORIGINAL ARTICLE

Application of antibacterial and water repellent finish for sewage cleaners workwear

C. S. Sentthil Kumar, S. P. Ashika, B. Ishwarya, V. Swetha

Department of Fashion Technology, Kumaraguru College of Technology, Coimbatore, Tamil Nadu, India

Abstract

Background: The work is about "Development of workwear for sewage cleaners." Antibacterial and water repellent finish has been applied to the cotton woven fabric to be developed into a workwear for sewage cleaners. **Materials and Methods:** The *Aloe vera* (150 gpl, 75 gpl, and 50 gpl) has been applied to the fabric imparting antibacterial activity by the pad-dry-cure method. The *A. vera* treated fabric was then imparted with water repellence using fluorocarbon (80 gpl and 50 gpl) using the pad-dry-cure method. **Results and Discussion:** The effectiveness of antibacterial, water-repellent finish for various concentrations were tested. The tests include comfort and chemical property to ensure the performance properties of the textile fabric. The basic test done here is antibacterial, water repellent, wettability, wickability, air permeability, and water permeability. **Conclusion:** The research shows that the wettability and wickability decrease in the coated fabric as the concentration increases. Moreover, the antimicrobial activity of the cotton fabric against *Escherichia coli* is restricted after it has been treated with *A. vera*. Thus, it is inferred that work wear treated with *A. vera* and fluorocarbon provide better hygiene to the sewage cleaners.

Key words: Aloe vera, antibacterial, fluorocarbon, Sewage cleaner workwear, water repellent, wettability, wickability

INTRODUCTION

Textile goods are an excellent substrate for growing microorganisms. Several microorganisms are present in the drainage which causes serious health hazards to sewage cleaners. Current work is in the interest of facilitating protection to sewage cleaners who are exposed to the harmful environment. Sewage workwear should have not only antimicrobial properties but also water barrier properties. In addition, the textile used in hotels, transportation, and biological institution needs antimicrobial textiles. The main objective of the work is to study the effect of antimicrobial and water repellent finish on the comfort properties of the fabric.[1]

MATERIALS AND METHODS

Aloe Vera

Aloe barbadensis Miller (*A. vera*) plant is found to be more useful to the humankind because of the medical properties it possesses.[2] It is known for its medical and healing properties for centuries.[3] It is extensively used for wound healing, psoriasis, skin injury, and diabetes.[4,5]

Extraction Process

A. vera gel is extracted from the center of the plant's leaves, contains colloid matter that gives it a semisolid consistency. In the extraction, process leaf is cleaned with water to remove the adhering dust, microbes, and insects and then it is cleaned with water containing 5 ppm chlorine to ensure it is free from pathogen, etc. The leaves are crushed between two pressure rollers to extract gel.[6,7]

Microbial Finish with Aloe vera Gel

The *A. vera* gel in three different concentration is applied on the cotton fabric with pad-dry-cure method.[8] In the first case, 30 ml of aloe gel is used with 20 ml of water. In a second case, 40 ml of aloe gel is mixed with 10 ml of water. In the third case, 50 ml of aloe gel is used.

Address for correspondence:
C.S. Sentthil Kumar, Department of Fashion Technology,
Kumaraguru College of Technology,
Coimbatore - 641049, Tamilnadu, India.

Received: 07-08-2018
Revised: 16-09-2018
Accepted: 27-09-2018

Under favorable conditions of humidity, heat, and nutrition (sweat and urea), bacteria can grow rapidly on human skin and the textiles. They convert sweat into stinking substances such as acids, aldehydes, and amines causing undesired diseases shown in Table 1.

Antimicrobial Finish

The antimicrobial activity is measured in terms of occurrence of the zone of inhibition. The resisted zone by finish and which is not affected by the bacteria is known as antibacterial, and that of fungi is antimycotic.[9,10]

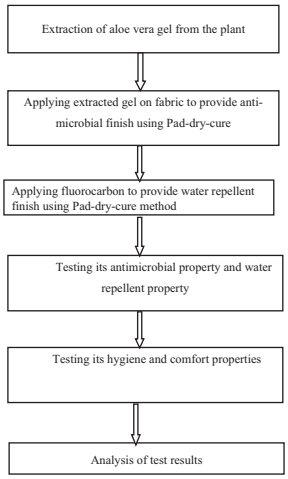
The chemical which is used as antimicrobial activity; it can be applied to the textile material by exhaust, pad-dry-cure, coating, spray, and foam techniques.

Evaluation of Antimicrobial Finishes

The AATCC Technical Manual12 has a number of test methods that are useful for evaluating antimicrobial finishes on textiles. These tests are summarized in Table 1. Two types of antimicrobial tests are dominant, the agar-based zone of inhibition tests and the bacteria counting tests. The relatively new ISO/DIS 20645 and the corresponding EN ISO Antibacterial Agents in Textile Industry 40320645 are based on the agar diffusion test, and ISO 11721 is a burial test (part 1 for the determination of an antimicrobial finish and part 2 for the determination of the long-term resistance).[11]

METHODOLOGY

Method



Materials

Fabric

Bleached 100% plain-weave cotton fabric was used.

Table 1: Microorganism causing diseases

Type of Bacteria	Type of Fungi
Staphylococcus pyogens	*Penicillium funiculosum*
Staphylococcus aureus	*Aspergillus niger*
Pseudomonas aeruginosa	*Chaetomium globosum*
Coagulase-negative Staphylococci	*Aureobasidium pullulans*
Enterococci	*Trichoderma sporogenes*
Escherichia coli	*Epidermophyton*

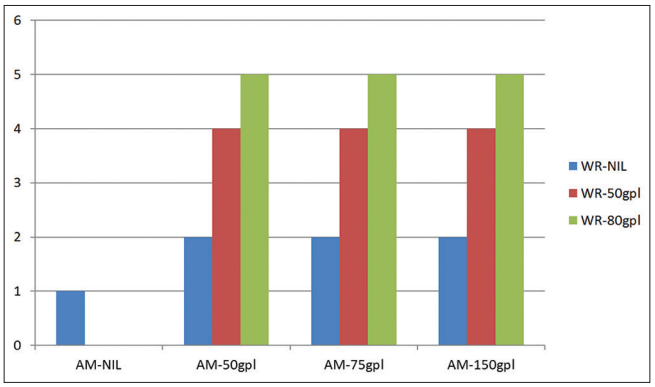


Figure 1: Wettability

Figure 2: Before water repellent finish

Chemicals

A. vera and fluorocarbon (Spiropel 555) were used for imparting antibacterial and water repellent activity, respectively.

Antimicrobial Finish

Table 2 Discusses the methods for evaluation of antimicrobial finishes for various textile materials. *A. vera* gel is applied to the cotton fabric using the pad-dry-cure method with three different concentrations such as *A. vera*: 150 gpl, 75 gpl, and

Table 2: Evaluation of antimicrobial finishes

Antibacterial activity of textile materials: Parallel streak method and test method 147 (agar plate test)	Rapid qualitative method for determining antibacterial activity of treated textile materials against both Gram-positive and Gram-negative bacteria. The treated material is placed on nutrient agar that is streaked with test bacteria. Bacterial growth is determined visually after incubation. Antibacterial activity is demonstrated by zones of inhibition on and around the textile.
Antibacterial finishes on textile materials, assessment of test method 100	A quantitative method for determining the degree of antimicrobial activity of treated textiles. The amount of bacterial growth in inoculated and incubated textiles is determined through serial dilutions and subsequent inoculations of sterile agar. Gram-positive and Gram-negative bacteria are used.
Antifungal activity, assessment of textile materials: Mildew and rot resistance of textiles and test method 30	Four methods for determining the antifungal assessment on textile properties of treated textiles. One method involves testing fabric properties after burial in soil that contains fungi. In a second method, cellulose fabric is textiles; exposed to *Chaetomium globosum* on an agar plate and the subsequent growth visually determined. The third method exposes textiles to *Aspergillus niger* on an agar plate and visually determines any fungal growth. The fourth method uses a humidity jar to expose textiles to a mixture of fungi spores. Any growth on the textile is visually determined.
Antimicrobial activity assessment of carpets; test method 174	Methods are given for the qualitative and quantitative determination of antibacterial activity and the qualitative evaluation of antifungal properties of carpet samples using procedures and materials similar to those in the above test methods.

Table 3: Finishing details

Sample No	Antimicrobial (gpl)	Water repellent (gpl)
1 (Controlled sample)	Nil	Nil
2	50	Nil
3	50	50
4	50	80
5	75	Nil
6	75	50
7	75	l80
8	150	Nil
9	150	50
10	150	80

50 gpl. Drying and curing temperatures are maintained at 130°C and 160°C, respectively.

Water Repellent Finish

Table 3 Lists the concentration levels of antimicrobial and water repellent finish applied onto the fabric. The water repellent finishing on *A. vera* treated cotton fabric is given with fluorocarbon (Spiropel 555) in two different concentrations using the pad-dry-cure method. Table 4 provides details of fabric parameters.

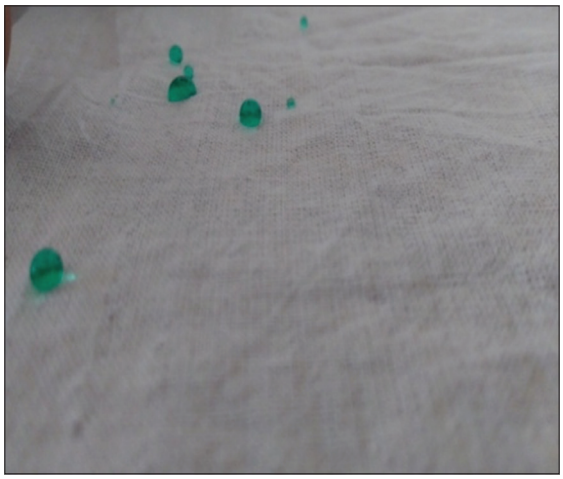


Figure 3: 50 gpl water repellent

RESULTS AND DISCUSSION

Weight of the Cotton fabric = 105 g/m^2

Tensile strength

Table 5 indicates the tensile strength and Extension% both in warp and weft directions

Wettability

Table 6 Provides wettability of fabric samples under various

Figure 4: 100 gpl water repellent

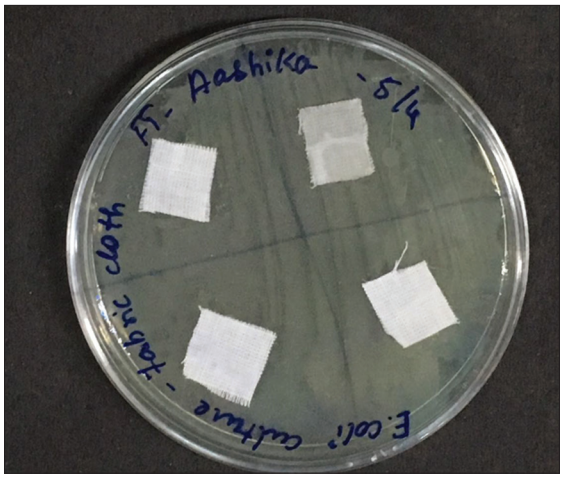


Figure 6: Antimicrobial activity test (samples 4, 5, 6, and 7)

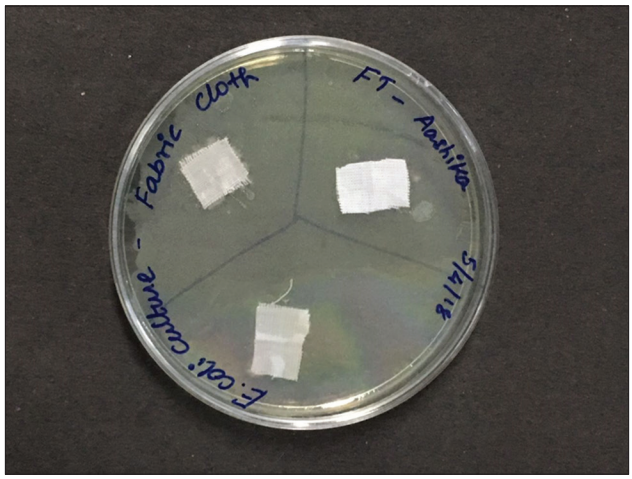


Figure 5: Antimicrobial activity test (samples 1, 2, and 3)

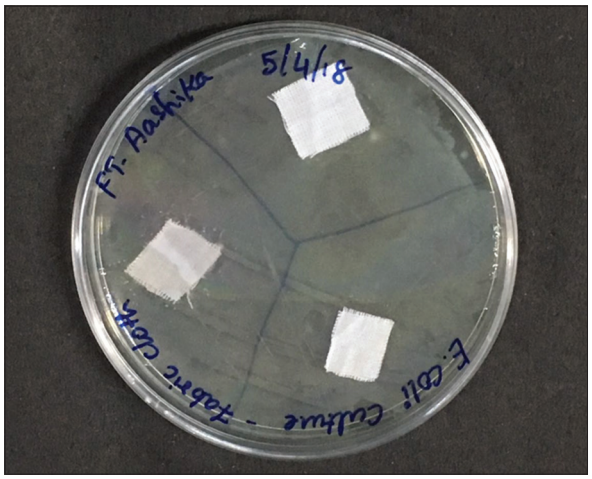


Figure 7: Antimicrobial activity test (samples 8, 9, and 10)

Table 4: Fabric details

S. no	Warp Count (Ne)	Weft Count (Ne)	EPI	PPI	Warp cover factor	Weft cover factor	Fabric cover factor
1.	23	21	95	69	19.80	15.05	24.21
2.	25	20	97	72	19.40	17.22	24.69
3.	27	20	94	71	18.09	15.89	23.71
4.	26	19	96	70	18.82	16.06	24.08
5.	24	21	93	68	18.90	14.84	23.72
Mean	25	20	95	70	19	15.81	24.08

Table 5: Tensile strength

S. no	Tensile Strength (Warp)	Extension %	Tensile Strength (Weft)	Extension %
1.	23.40	6.20	18.77	8.00
2.	23.00	7.40	17.60	7.80
3.	22.50	7.20	20.10	6.20
4.	24.10	5.60	19.40	7.40
5.	23.40	6.20	20.10	8.10
AVG	23.28	6.52	19.21	7.50

Table 6: Wettability

Anti microbial (gpl)	Water repellent gpl	Grade	Description
NIL	NIL	1	Complete wetting of the whole of the sprayed surface.
50	NIL	2	Wetting of more than half the sprayed surface.
50	50	4	No wetting but adherence of small drops to the sprayed surface.
50	80	5	No wetting and no adherence of small drops to the sprayed surface.
75	NIL	2	Wetting of more than half the sprayed surface.
75	50	4	No wetting but adherence of small drops to the sprayed surface.
75	80	5	No wetting and no adherence of small drops to the sprayed surface.
150	NIL	2	Wetting of more than half the sprayed surface.
150	50	4	No wetting but adherence of small drops to the sprayed surface.
150	80	5	No wetting and no adherence of small drops to the sprayed surface.

Table 7: Wickability (before finishing)

Height (cm)	Time (min)	
	Wrapway	Weft way
1	0.016	0.03
2	0.05	0.06
3	0.16	0.20
4	0.50	0.10
5	2	2.20
Mean	0.54	0.52

concentration levels of anti-microbial and water repellent. Wettability decreases in the coated fabric as the water repellence concentration increases.

Wickability

Table 7 Depicts Wickability (before finishing) in terms of time in minutes and sample height in centimeter. As sample length increases time taken to wick also increases.

After the application of water repellent finish there is no wicking sample both in warp and weft directions.

After Water Repellent Finish

There is no wicking in after water repellent finished fabric or it has very slow wicking.

Wickability decreases in the coated fabric as the water repellence concentration increases, and it does not allow the water to pass through.

Antimicrobial Activity Test

The antimicrobial activity of the cotton fabric against *Escherichia coli* is restricted after it has been treated with *A. vera*.

CONCLUSION

The research shows that the wettability and wickability are drastically reduced after water repellent finish. Similarly, the antimicrobial activity of the cotton fabric against *E. coli* is restricted after it has been treated with *A. vera*. Thus, it concludes that *A. vera* and fluorocarbon applied material has good antibacterial and water repellent activity and is a ideal material for sewage cleaner workwear. It is also established that water repellence treatment enhances the life of antimicrobial finish.[12]

REFERENCES

1. Gopalakrishnan D, Aswini RK. Antimicrobial finishes. Melliand Int J 2002;8:148-51.
2. Krishnaveni V, Srinivasan J. Investigation of phytochemical and anti-bacterial activity on *Rhizophora apiculata* ethanolic extract for medical textile applications. J Microbiol Environ Sci 2017;19:S8-11.
3. Kumar CS, Dhinakaran M, Kumar TS, Dhivyaroopa V, Ishwarya R, Vinodhini S. Development of wet wipes from natural herbal extracts. Asian J Microbiol Biotechnol Environ Sci 2017;19 Supp l:12-5.
4. Shahidi S, Wiener J. Antibacterial agents in textile industry. Sci Total Environ 2006;19:388-404.
5. Dhinakaran M, Kumar CS, Kumar T. Development of sericin coated knitted polysterblend fabric used for wound dressing. J Adv Res Dyn Control Syst 2017;9:16.
6. Gao Y, Cranston R. Recent advances in antimicrobial treatments of textiles. Text Res J 2008;78:60-72.
7. Krishnaveni V, Ampritha S. Analysis of phytochemical and anti-microbial activity on *Vetiveria zizanioides* ethanolic extract for healthcare applications. Int J Pharm Bio Sci 2016;7:758-65.
8. Jantas R, Gorna K. Antimicrobial finishing of cotton fabrics. Fibre Text East Eur 2006;14:88-91.
9. Sathianarayanan MP, Bhat NV, Kokate SS, Walunj VE. Antimicrobial finish for cotton fabric from herbal

products. Indian J Fibre Text Res 2010;35:50-8.
10. Jyothi D. Experimental study on antimicrobial activity of cotton fabric treated with aloe gel extract from *Aloe vera* plant for controlling the *Staphylococcus aureus* (bacterium). Afr J Microbiol Res 2009;3:228-32.
11. Renaud FN, Doré J, Freney HJ, Coronel B, Dusseau JY. Evaluation of antimicrobial finish in a hospital environment. J Ind Text 2006;36:54-60.
12. Gouda M, Ibrahim NA. New approach for improving antimicrobial functions of cotton fabric. J Ind Text 2008;37:327-39.

Source of Support: Nil. **Conflict of Interest:** None declared.