



COMPARATIVE STUDY OF COTTON FABRIC FINISHED WITH COMMERCIAL AND BIO-ACTIVE ANTIBACTERIAL AGENT BY DIP-DRY AND PAD-DRY METHODS

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ABSTRACT

Antimicrobial agents are applied on textiles to suppress or control the growth of microbes on textiles. Cotton fabric taken for this study was finished with triclosan and culture filtrate of *Streptomyces fradiae* CQLW to develop antibacterial property. Antibacterial activity of the culture filtrate was checked via well diffusion method. The impact and effectiveness of finishing methods (pad-dry and dip-dry) were also determined. Antibacterial activity was evaluated after completion of each laundering cycle and after 5 cycles was found to gradually decrease. Various properties like geometrical, mechanical and physical was evaluated to know the changes from their normal values. Pad-dry method was found to be effective in improvement of physical parameters. Obtained results were subjected to ANOVA to check for the significance of the study.

KEYWORDS: Pad-Dry method, Culture filtrate, Dip-dry method, Laundering, Physical parameters, *Streptomyces fradiae* CQLW, Triclosan.

INTRODUCTION

Textile and apparel products made from natural fiber are readily attacked by microbes because of the large surface area and the material's ability to retain moisture (Szostak-Kotowa, 2004). Manufacturers are much bothered about the deterioration effect caused by microbes during storage. So a large demand exists for antimicrobial finished textiles to avoid bio deterioration, odor generation and all other types of textile mediated infections. Several synthetic antimicrobial agents are available in market, but these are not eco-friendly and user-friendly. Several environmental and health issues have been reported already. One such example is triclosan which is not soluble in water, in general methanol is used to dissolve it to finish fabric. This method is highly expensive and as mentioned earlier so many environmental problems are also reported in many countries. Counting all these problems use of triclosan has been banned in many countries. New scenario in textile focuses on biologically derived antimicrobial agents to avoid the use of chemical agents. It must be ensured that the finish is permanently effective and at the same time compatible with skin and free from pollution (Joshi *et al.*, 2009). Use of these agents promotes natural and eco friendly life style.

The present work focuses on determining the effective finishing method among dip-dry and pad-dry method. Triclosan reported to be used commercially for antimicrobial finishing is taken as control for comparison any changes in properties in the quality of fabric after antimicrobial finishing was also evaluated as per standard protocols.

MATERIALS AND METHODS

Fabric used

Biodeterioration was found to be a major problem with natural textiles. Hence commercially available cotton woven fabric was used in the study.

Scouring

The fabric was first scoured to remove the natural impurities present in cotton and to improve the absorbency of the fabric. The fabric was boiled with Sodium Hydroxide (NaOH -1 g/l) solution at 80 °C for 1hr. Then the fabric was squeezed, dried at room temperature and used for further study (AATCC Protocol).

Antibacterial activity of filtrate and triclosan

Well diffusion assay (CLSI method 2014) was performed to check the activity against the test organisms that cause deterioration in fabrics viz. *Bacillus subtilis*, *Bacillus*.

megaterium, *Pseudomonas. aeruginosa* and *Pseudomonas. fluoresce*. Plates were swabbed with overnight culture and wells were punched and filled with filtrate and triclosan. After overnight incubation at 37°C development of zone of inhibition was observed.

Finishing of the fabric

Two methods were employed to accomplish anti-bacterial finish on the fabric, namely, dip-dry method and pad-dry method using *S.fradiae* CQLW culture filtrate and triclosan.

Dip-Dry method

In dip-dry method both sides of samples were surface sterilized with UV for 30 minutes. Fabric was dipped in the culture filtrate and boiled at 80 °C for 1 hr. Excess extract was squeezed out and samples were dried under shade.

Pad-Dry Method

Finishing of fabric with adequate mechanical strength can be done by this method. Chamber was filled with culture filtrate and the fabric was sent through a padding mangle to apply the finishing agent. when the finished fabric is passed through the two rollers the excess extract was squeezed out and an even coating was achieved. Then the fabric was shade dried.

Physical parameters analysis

After imparting the antibacterial agents, fabrics were analysed for changes in various physical parameters such as geometrical properties (fabric weight, fabric thickness), mechanical properties (tensile strength, pilling), comfort properties (stiffness, drape co-efficient, crease recovery, water repellency) following standard methods as described in ASTM / AATCC / ISO.

Table 1: Fabric weight.

Sl. No.	Fabric weight (g/m ²)				
	Control	Dip - dry		Pad -dry	
		CF	AB	CF	AB
1	117	114	116	123	119
2	114	116	115	132	121
3	115	118	117	122	117
Mean	115.3	116	116	125.6	119
SD	1.527	2.000	1.000	5.507	2.000
F		3.543		10.543	

CF-Culture filtrate, AB- Commercial antibacterial agent.

Sl. No.	Thickness of fabric (mm)				
	Control	Dip -dry		Pad- dry	
		CF	AB	CF	AB
1	0.32	0.34	0.33	0.35	0.33
2	0.31	0.34	0.35	0.30	0.31
3	0.30	0.37	0.31	0.35	0.30
Mean	0.31	0.35	0.33	0.33	0.31
SD	0.010	0.017	0.020	0.028	0.015
F		2.967		2.875	

CF-Culture filtrate, AB- Commercial antibacterial agent.

Table 2: Fabric thickness.

Sl. No	Tensile strength energy (kgf)							
	Dip -dry				Pad -dry			
	CF		AB		CF		AB	
	Warp	Weft	Warp	Weft	Warp	Weft	Warp	Weft
1	30.81	12.38	32.21	10.56	33.99	12.71	32.86	14.48
2	31.22	13.96	34.56	13.96	37.50	14.80	38.66	13.09
Mean	31.01	13.17	33.38	12.26	35.74	13.75	35.76	13.78
SD	0.289	1.117	1.661	2.404	2.481	1.477	4.101	0.982

Table 3: Tensile strength.

Sl. No.	Control	
	Warp	Weft
1	30.81	12.38
2	29.28	11.58
Mean	30.04	11.98
SD	1.081	0.565

CF-Culture filtrate, AB- Commercial antibacterial agent.

Table 4: Sinking test.

Sl. No.	Sinking test (Seconds)				
	Control	Dip- dry		Pad -dry	
		CF	AB	CF	AB
1	22.28	28.26	29.1	30.83	29.82
2	24.21	20.16	25.1	26.23	27.22
3	26.21	26.16	22.3	25.23	21.23
Mean	24.23	24.86	25.5	27.43	26.09
SD	1.965	4.203	3.417	2.986	4.405
F		11.231		12.097	

CF-Culture filtrate, AB- Commercial antibacterial agent.

Table 5: Capillary rise.

Sl. No.	Capillary rise test(cm)				
	Control	Dip - dry		Pad- dry	
		CF	AB	CF	AB
1	2.8	3.2	2.6	2.1	4.0
2	2.8	3.3	2.9	2.5	3.5
3	4	3.0	2.8	2.4	3.2
Mean	3.2	3.16	2.76	2.33	3.56
SD	0.692	0.152	0.159	0.208	0.404
F		10.221		10.345	

CF-Culture filtrate, AB- Commercial antibacterial agent.

Table 6: Fabric Stiffness.

Sl. No.	Stiffness(mg-cm)							
	Dip - dry				Pad -dry			
	CF		AB		CF		AB	
	Warp	Weft	Warp	Weft	Warp	Weft	Warp	Weft
1	1.17	1.2	1.2	1.2	1.4	1.5	1.3	1
2	1.22	1.3	1.9	1.4	1.9	1.4	1.4	1.6
3	1.32	1.1	1.7	1.6	1.8	1.2	1	1.3
Mean	1.23	1.2	1.6	1.4	1.7	1.36	1.23	1.3
SD	0.763	0.100	0.360	0.200	0.264	0.152	0.208	0.300
Sl. No.	Control							
	Warp	Weft						
1	1.8	1.4						
2	1.4	1.9						
3	1.5	1.7						
Mean	1.4	1.6						
SD	0.208	0.251						

CF-Culture filtrate, AB- Commercial antibacterial agent.

Table 7: Crease recovery.

Sl. No.	Crease recovery angle(degrees)				
	Control	Dip -dry		Pad -dry	
		CF	AB	CF	AB
1	61	62	62	65	62
2	60	60	60	62	60
3	60	59	59	60	60
Mean	60.33	60.33	60.33	62.33	60.6
SD	0.577	1.527	1.527	2.516	1.154
F		8.453		13.768	

CF-Culture filtrate, AB- Commercial antibacterial agent.

Table 8: Wash durability (Laundering).

Sl. No.	Number of wash cycle	<i>P.aeruginosa</i> (CFU/ml)	<i>P.fluorescence</i> (CFU/ml)	<i>B.megaterium</i> (CFU/ml)	<i>B.subtilis</i> (CFU/ml)
1	1 wash	22 X 10 ⁻³	21 X 10 ⁻³	20 X 10 ⁻³	22 X 10 ⁻³
2	2 wash	21 X 10 ⁻³	22 X 10 ⁻³	21 X 10 ⁻³	21 X 10 ⁻³
3	3 wash	22 X 10 ⁻³	23 X 10 ⁻³	20 X 10 ⁻³	22 X 10 ⁻³
4	4 wash	21 X 10 ⁻³	20 X 10 ⁻³	20 X 10 ⁻³	21 X 10 ⁻³
5	5 wash	22 X 10 ⁻³	21 X 10 ⁻³	22 X 10 ⁻³	21 X 10 ⁻³
6	6 wash	32 X 10 ⁻³	30 X 10 ⁻³	36 X 10 ⁻³	33 X 10 ⁻³



Figure 1: Well diffusion method and Bioactive strain CQLW.



Figure 2: Pad-dry and dip-dry method.

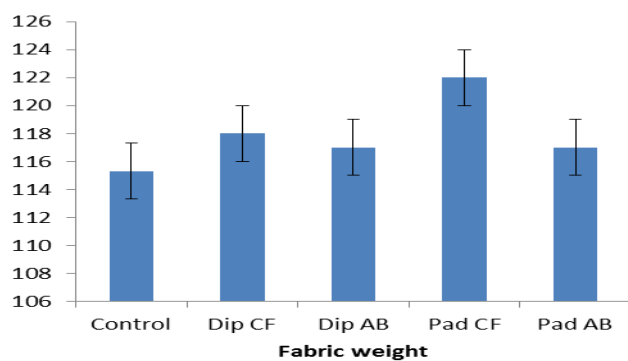


Figure 3: A) Fabric weight.



B) GSM cutter.

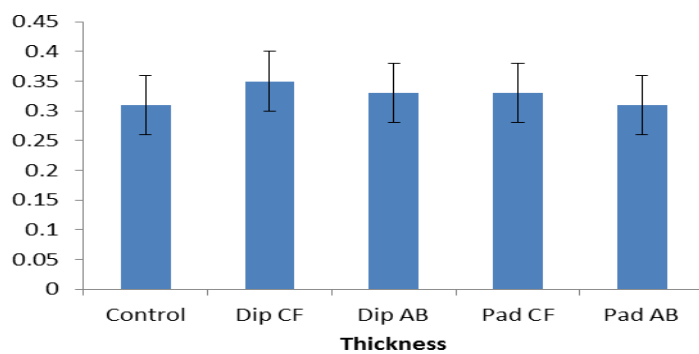


Figure 4: a) Fabric thickness



b) Thickness tester

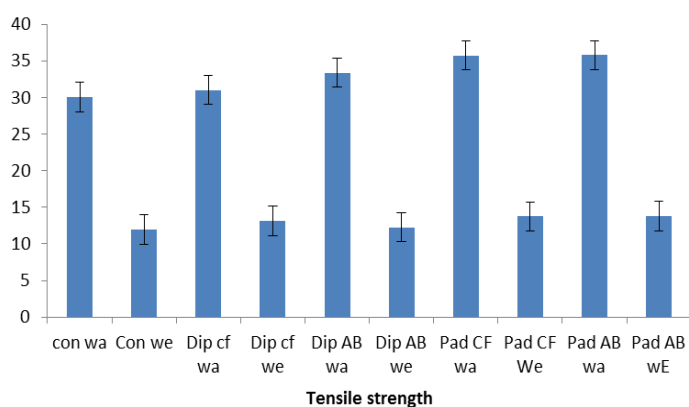


Figure 5: a) Tensile strength



b) Tensile strength tester



Figure 6: Pilling box.

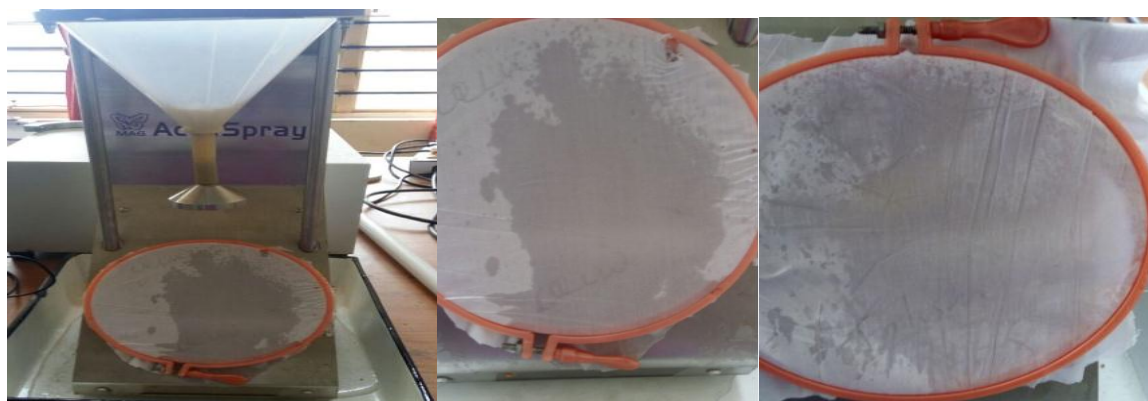


Figure 7: A) Spray test, B) Culture filtrate, C) Triclosan

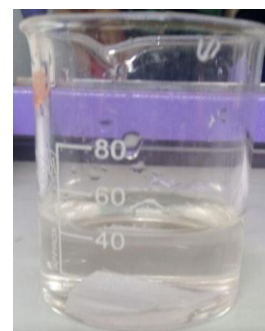
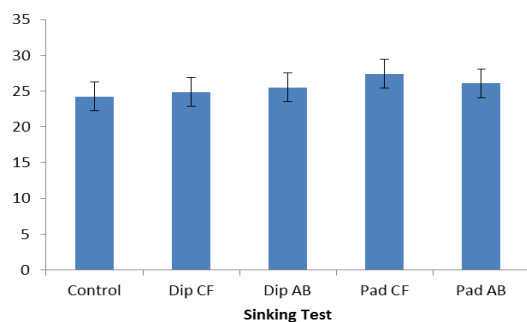


Figure 8: Sinking test.

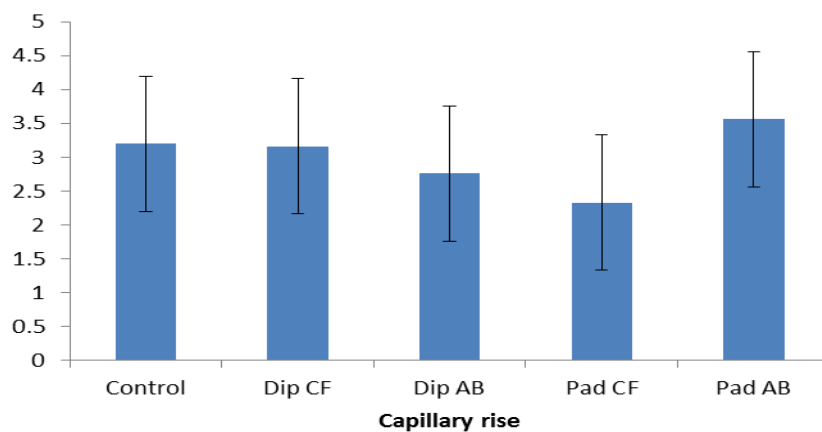


Figure 9: Capillary rise.

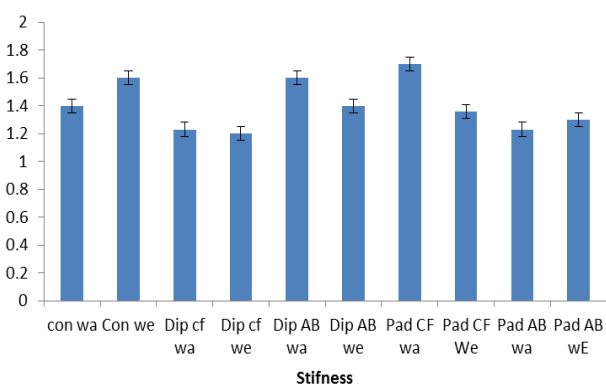


Figure 10: a) Stiffness



b) Stiffness tester

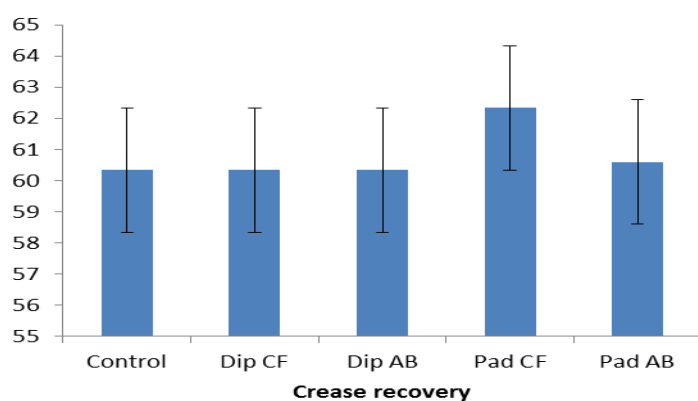


Figure 11: Crease recovery.





Figure 12: Drape.

Geometrical properties

a) Fabric weight (ASTM D3776-96)

Fabric weight, expressed in grams per square meter (GSM), was measured according to ASTM test method D3776-96: (Jiang and Guo, 2008). Fabric test specimens were cut with GSM cutter. An electronic weighing balance was used to find out the weight of the dissected sample. The weight in grams is multiplied by 100 to get the GSM and the procedure was repeated multiple times and finally average was calculated.

b) Thickness of fabric (IS 7702:1975)

The thickness tester has a broad anvil, upon which a pressure foot is pressed by spring. The dial indicates the thickness of the material in thousand of an inch between anvil and pressure foot (Trivedy *et al.*, 2016). Each division of the dial read 0.01mm. The area selected for checking should be free from crease and gauge reading was noted down after 30 seconds for five times.

Mechanical properties

a) Tensile strength

Tensile strength shows the behavior of the test sample under the axial load, from this breaking load and elongation can be obtained. MAG universal tensile tester is employed to measure the tensile strength of the test sample, as specified in ASTM D5305-06 standard test method for breaking force. Fabric test specimens were cut along warp and weft directions with the template supplied with the equipment. Each test specimen was held between the fixed and movable clamps. As per instructions given in the manual data's fed on the monitor to run the device and tensile strength was calculated

b) Pilling test ASTM D3152/2005

Pilling test is employed to find out surface fault of fabric characterized by little pills and giving unsightly appearance to surface (ASTM standards, 2005). This is formed by rubbing action on surface and the presence of loose fabrics on surface. ICI pilling box tester was used

for the test (Sumithra, 2012). For evaluation, each specimen was placed on the double faced tape.

Comfort properties

a) Fabric Drape co-efficient (IS-8357/1977)

This portrays the aesthetic quality of fabric. It is a complex property including bending and shearing deformation. The drape coefficient of fabric is measured in terms of drape coefficient $F(\%) = [(D-a)/(A-a)] \times 100$

a= area of supporting stand 12.5 cm diameter

A= area of test specimen 25 cm diameter

D=area of drape pattern

$D = K \times w/W$

K= correct factor of divergence of light rays (0.91)

w=mass of drape pattern

W=mass of ammonia process paper in grams per square cm

b) Crease recovery (AATCC66-2008)

This test method is used to determine the crease recovery of fabric. A test specimen is folded and compressed under controlled conditions for a time and force to create crease. The test specimen is then suspended in test instrument for a controlled recovery period, after which the recovery angle is recorded for 5 minutes.

c) Stiffness test

Method for determination of stiffness of fabric was denoted by following Indian standard, 1971. The horizontal strip fabric is allowed to bend under its own weight. The specimen was pushed, and the scale slowly and steadily moved, when the leading edge projected beyond the edge of the platform. An increasing part of specimen would overhang and start bending under its own weight. The length of the overhanging portion was noted in the scale in both warp and weft direction.

d) Absorbency test (Drop test)

A burette filled with distilled water was clamped in a stand. The fabric was mounted in an embroidery frame and placed with the base of the stand. The nozzle of the

burette was just opened to allow a drop of water to fall on sample (AATCC 79-2007). 100 ml of distilled water was poured into the funnel and the whole quantity sprayed on the test specimen. After complete spraying the specimens are compared with the area of moisture absorbance with AATCC standard chart as reference.

Sinking test (AATCC17-2005)

Sinking involved a simple test for wettability of fabric. Time taken by the piece to sink just beneath the water surface was measured. A 100 ml beaker was filled with 50 ml distilled water. The finished fabrics were cut in to 1x1 cm and dropped on the surface of the water from a constant height. The time taken by the fabric to sink completely and settle at the bottom of the beaker is noted.

Capillary rise test

In this method, wick up was observed by determining the rate at which the water moves upward on a fabric strip (Kandhavativu *et al.*, 2011). Fabrics were cut in to equal size and attached to a block. A portion of fabric about 2 cm should be immersed inside the water. After 60 seconds, rate of water level above 2 cm is noted down.

Wash durability of the finished fabric (AATCC 60)

Wash durability test of finished fabric was carried out by using neutral soap solution at 40 °C (+/- 2) for 30 minutes in the ratio material: liquor 1:50, followed by rinsing and drying (Sarkar *et al.*, 2003). After each washing dried fabrics were subjected for antibacterial activity checking. Activity was assessed by AATCC100 method. The test was repeated till the activity diminishes.

RESULTS AND DISCUSSION

Antibacterial activity

Plates were observed for antibacterial activity after incubation time and zone of inhibition was observed against all test pathogens for triclosan as well as filtrate (Figure 1). From the results it has been concluded that filtrate is having good antibacterial activity. Among the isolated 15 strains CQLW showed highest inhibition against all test pathogens but it was lesser than triclosan for 2-3mm in zone diameter.

Figure 1: Well diffusion method.

Finishing of fabric

Samples were coated via dip-dry and pad-dry methods (Figure2) for culture filtrate and commercial standard triclosan. In dip-dry after scouring fabric was boiled for 1 hr, excess filtrate was squeezed and shade dried. In padding mangle fabric passed in between rollers and with mechanical power antibacterial agents was applied on both sides. After shade drying fabrics coated with triclosan and filtrate separately was subjected for physical property analysis.

Figure 2: Pad-dry and dip-dry method.

Geometrical properties

A) Fabric weight

Mass per unit area of fabric was calculated, and each were expressed in grams per square meter. (Table 1) and Figure 3 (A) (B)). Results indicate that pad-dry method is more efficient than the dip- dry method. From the statistical analysis, it was evident that the fabric finished with culture filtrate exhibited fabric weight of 125.6 g/m² by pad-dry method and 116 g/m² by dip-dry method. It was also noted that culture filtrate gave better result over control and commercial standard. It simply represents how much 1 square meter of fabric weighs and gives an idea about the density of the fabric. Higher the Grams per square meter for denser the fabric and vice versa. GSM is one of the most important factors to ascertain the quality parameters of durability as well as processing requirements of the textile substrate. Fabric for different end uses/applications is selected based on the grammage of the material. For rigorous/abrasive application fabric with heavy Grams per square meter is preferred where as low GSM fabric is preferred for clothing and comfort purpose. Zuber *et al* 2011 also reported the improvement of fabric weight after finishing with softener. Preparation of amino silicone based softeners with different emulsifiers and its applications onto the surfaces of cotton and cotton/polyester blend fabrics. The application of the prepared softeners has imparted anti-pilling property to the fabric. It can be seen that there is a remarkable increase in weights of treated fabrics as compared to the untreated.

Table 1: Fabric weight.

Figure 3: A) Fabric weight B) GSM cutter

B) Thickness of fabric (IS 7702:1975)

Thickness is an important variable in determining fabric stiffness, drape, comfort, permeability of water and air, abrasion resistance. Results exhibited that the thickness of fabric finished with culture filtrate is 0.35 mm by dip-dry method which is better than the pad-dry method that showed 0.33 mm. Table 2 and Figure 4 represents the result of test. Increase in fabric thickness will reduce both air and water permeability and hence reduce microbial attack. Also, the comfort would improve and drape would decrease with increase in thickness. Results also showed better result over the commercial standard. Fabric thickness is dependent on the fabric weave as well as the thread's position in the binding repeat. If we have the same yarn parameters (yarn count, twist, yarn under fill, etc.), higher derived weaves with a long float have greater fabric thickness than plain weave with a small float. The same effect arises with the determination of the fabric's air-permeability

Table 2: Fabric thickness.

Figure 4: a) Fabric thickness b) Thickness tester

Mechanical properties

A) Tensile strength and elongation

Results are given in Table 3 & Figure 5. Maximum value observed for fabric finished with commercial antibacterial agent in warp and weft direction are 35.76 and 13.78 kgf respectively using pad-dry method using triclosan over control and culture filtrate. In 2010 Ibrahim *et al* 2010 reported that triclosan treated fabric had higher tensile strength for cotton blend/polyester which treated with commercial available standard to improve the antibacterial activity. Tensile strength of any material is the force at which specimen breaks final application of fabric can be decide by this tensile strength.

Table 3: Tensile strength.

Figure 5: a) Tensile strength b) Tensile strength tester.

B) Pilling test ASTM D3152/2005

Pilling resistance test method is intended for the determination of the resistance of textiles of all kinds in all forms to the action of an applied resistive force. Pilling is the formation of small balls due to a surface defect of textiles caused by wear. It is caused by abrasion on the surface of the fabric. There is no pilling in the fabric coated with culture filtrate using dip-dry and pad-dry methods after 5000 cycles (Figure 6). Zuber *et al* 2011 studied the preparation of amino silicone based softeners with different emulsifiers and its applications onto the surfaces of cotton and cotton/polyester blend fabrics. The application of the prepared softeners has imparted anti-pilling property to the fabric Anti pilling property will increase the comfort property of fabrics

Figure 6: Pilling box.

Comfort properties

A) Absorbency test -AATCC 79-2007, (Drop test)

A burette filled with distilled water was clamped in a stand. The fabric was mounted in an embroidery frame and placed with the base of the stand. The nozzle of the burette was just opened to allow a drop of water to fall on sample (AATCC Technical Manual, 2008). After complete spraying the specimens are compared with the area of moisture absorbance with AATCC standard chart (Figure 7(A)(B)). 50% spray test rating noted for culture filtrate coated fabric by pad-dry and 70% wetting noted for dip-dry finished fabric for triclosan. Poor wetting will enhance the quality of fabric by reducing the microbial growth. So it has been concluded that pad dry method is better for finishing to improve the water repellency.

Figure 7: A) Spray test, B) Culture filtrate C) Triclosan

B) Sinking Test (AATCC17-2005)

A 100 ml beaker was filled with distilled water. The fabrics were cut in to 1x1 cm and dropped on the surface of the water from a constant height. The time taken by

the fabric to sink completely and settle at the bottom of the beaker is noted. This method also known as floating method also used to see the shrinkage of fabric. Table 4 and Figure 8 show the absorbency property of sample. Taking more time for sinking represents poor wetting of fabric. 27.43 seconds taken by fabric finished with culture filtrate using pad-dry was observed to be better than dip-dry. Low sinking time indicates rapid wetting. It can also be concluded that the less absorbency of moisture will reduce the attack of microbes.

Table 4: Sinking test.

Figure 8: Sinking test.

C) Capillary rise test

In this method, wick up was observed by determining the rate at which the water moves upward on a fabric strip .Results exhibited minimum distance travelled by water in the fabric finished with culture filtrate 2.33 cm by pad-dry method and 2.76 is the least distance noted by triclosan, which is greater than culture filtrate. This result also supports the resistance to water absorbency by fabric (Table 5& Figure 9).The liquid can wet the surface by transport through the inter fiber –space. Less distance represents the closed arrangements of yarns in warp and weft direction and vice versa. Improved absorbency resistance fabric will discourage the growth of microbes.

Table 5: Capillary rise.

Figure 9: Capillary rise.

D) Stiffness

Shirley stiffness tester was used to find out the stiffness, based on cantilever principle. The horizontal strip fabric is allowed to bend under its own weight. Higher the bending length more is the stiffness of fabric. Stiffness is the resistance offered by material to a force which tends to bend it. Increasing length of bending indicates better stiffness of fabric (Table 6, Figure 10). Maximum stiffness was observed in warp direction is 1.7 mg/cm for culture filtrate using pad-dry and 1.6 mg-cm in weft direction exhibited by control. The degree of fabric stiffness related to fiber material, yarn and fabric structure. End use can be fixed after seeing the stiffness of the fabric.

Table 6: Fabric Stiffness.

Figure 10: a) Stiffness b) Stiffness tester

E) Crease recovery (AATCC66-2008)

Unintentional fold in fabric that may be introduced at some stage is called crease. Crease recovery is the property of the fabric to recover back to its original position after removal of certain load from the fold fabric (Wang *et al.*, 2013). This test method is used to determine the crease recovery of fabric. A test specimen is folded and compressed under controlled conditions for a time and forced to create crease. The recovery was measured in terms of the extent of angle to which it had been recovered (Table 7 Figure 11). Results concluded

that maximum recovery was obtained for the fabric coated with culture filtrate (62.33) using pad-dry method over dip-dry method. Robati and Branch 2007 studied the three different emulsifiers (E1-ethylene oxide, E2-texapon N70, E3-mono ethylene glycol) which were mixed with silicone oil and its influence on cotton fabrics was studied. Also, it was concluded that with increasing the add on percentage of softener, the crease recovery angle increased

Table 7: Crease recovery.

Figure 11: Crease recovery.

F) Fabric Drape co-efficient

Fabric drape was the hanging property of the fabric and inversely proportional to drape coefficient (IS, 1977). The term used to describe the way the fabric hangs under its own weight and look forward how garment looks in use. Fabric drape was the hanging property of the fabric and inversely proportional to drape coefficient [IS, 1997]. This portrays the aesthetic quality of fabric. It is a complex property including bending and shearing deformation. Drape is the ability of a fabric to fall under its own weight into wavy folds of different nature. Drape of culture filtrate using pad dry is 59% (Figure 12) which is lesser than both control and dip-dry method. Lesser drape co-efficient of sample indicates it has less shrinking and will be good for long time wearing.

Figure 12: Drape.

Wash durability of the finished fabric (AATCC 60)

Wash durability test was carried out for coated fabric. The main objective of this method to make sure about how long the antimicrobial property can withstand on fabric after washing. It was observed that antimicrobial activity was retained up to 5 wash cycle. After 5 washing cycles antimicrobial activity gradually decreased and results are recorded in Table 5. Retention of antibacterial activity up to 10 washing cycle in combination with mordant was reported by Rathinamoorthy et al., 2013 with extract of *P.granatum* and *T.chebula* against *S.aureus* and *E.coli* and they reported after 5 washing antimicrobial activity reported and followed by 10 washing gradually decreased. From the result it has been concluded that the compound has attached to fabric by dip-dry coating and it can withstand up to 5 wash cycle without any mordant, giving promise to avoid the chemicals as mordant.

Table 8: Wash durability of coated fabric (Laundering).

CONCLUSION

Development of textiles with durable natural antibacterial agents is very important to overcome the problems of commercially available synthetic agents that are quite harmful. Bioactive culture filtrate from *S.fradiae* CQLW was coated on cotton fabric using pad-dry and dip-dry methods and then compared with the

control samples. ANOVA results of geometrical, mechanical and comfort properties exhibited that the fabric finished with culture filtrate by pad-dry method is superior to the counterpart finished by dip-dry method. At the same time, the fabric finished with culture filtrate is better than the fabric finished with commercial antibacterial agents. Hence the study proves that the antibacterial derived from culture filtrate of *S.fradiae* CQLW is a better alternative to synthetic antibacterial agents for textile finishing. It is promising that the bioactive culture filtrate is both user- and environment-friendly with prospective antibacterial finishing of textiles.

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Disclosure statement

No potential conflict of interest was reported by the authors.

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