COMPARISON OF TREATED AND UNTREATED COTTON FABRIC WITH ANTIMICROBIAL FINISH

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ABSTRACT: This study was carried out to find the relationship between application of antimicrobial finish and performance level on cotton fabrics to observe that antimicrobial finish either enhances or deterioates the properties or even properties remain the same. The main purpose of this study was that antimicrobial finished garments will be used by the common person in everyday life. The properties on which antimicrobial finish affect was seen are abrasion resistance, crease recovery, tensile strength and wrinkle recovery. True Experimental design was used. In pre-test fabric properties were checked. Microorganisms' presence was checked before and after applying antimicrobial finish. In post-test after applying antimicrobial finish properties were again checked for comparison. Dependent t-test was applied where appropriate for data analysis. The results revealed that antimicrobial finish positively affect the crease recovery while abrasion resistance and wrinkle recovery remain the same on both treated and untreated samples. On the other hand antimicrobial finish negatively affects the tensile strength. Aloe vera antimicrobial agent was used; it is an herbal agent so is not harmful for the wearer and also for the fabric. The antimicrobial finish deteriorates 74% the presence of microorganisms

INTRODUCTION

The consumers are now increasingly aware of the hygienic life style and there is a necessity and expectation for a wide range of cotton fabric treated with antimicrobial finish. In the present day world most of us are very conscious about our hygiene's and cleanliness. Clothing and textile materials are not only the carriers of microorganisms such as pathogenic bacteria, odour generating bacteria and mould fungi, but also good media for the growth of the microorganisms. When fabric is worn next to skin, infestation by microbes causes cross infection by pathogens and development odours. The performance properties of cotton fabric are loss as a result of microbial attack. The antimicrobial finishes are applied to textile materials for two purposes as to protect the wearer and the cotton fabric itself Bonin, Ramachandran,[1,2 respectively]. The antimicrobial finish is applied in such a way that appearance and feel of the fabric is not change and no chemical odour remains. On the other hand dry cleaning does not affect the finish.

Antimicrobial fabric can be beneficial to a wide variety of people. Alovera gel was used to treat the fabric as an antimicrobial agent. Since the target audience for this research is general public. So Alovera gel is an appropriate agent, which have no harmful effect to human beings.A wide range of textile products need to be treated with antimicrobial finish. Since the only antimicrobial textiles currently on the market are either disposable or used primarily for odour control. The use of antimicrobial textiles effective against harmful pathogens will be limited to medical industry workers and patients but not to the general public. Antimicrobial textiles can be useful for recovering patients, people with immunodeficiency viruses, and those with low immune systems such as premature babies. Antimicrobial finish is also needed for undergarments both for adult and children. The findings are also applicable to the sportswear and footwear industries. There is a need for this type of product.

Bonin [1] found that controlling moisture is a major concern because microorganisms only attack fibers when they are damp. Moisture control is linked to odour control because the sweat that produces the odour can also increase the damage to textile by providing a moist environment for mildew to grow. When this mildew attacks on fabrics, it will cause staining and discoloring the textile.

Purohit *et al.* (2006)[3] state that 'micro' means 'small'. Microbiology is the branch of biology which deals with the study of small living organisms. It deals with the study of microscopic organisms called microbes which are unicellular. These microorganisms widely distributed in air, water, soil, sea water and also in the bodies of living plants and animals. Stout [4] found that the tropical and sub-tropical condition of high relative humidity (above 75%) and warm temperature (above 80^{o}F) favour development of these organisms. The cellulosic material especially those containing starch or sizing material are more susceptible for the attack of these organisms. Purohit *et al.*[3] found that causative agents for most of the infectious agents were discovered in last 120 years. There was a connection between micro-organisms and diseases whose causes were previously unknown. The humans have to live with micro-organisms because they cannot live without them. Ingraham and Ingraham (2000)[5] investigated that microorganism divided into classes as bacteria, algae, fungi, protozoa and viruses which are not closely related. Only a single property which linked them is their small sizes.

Bacteria are distinguished by small size and can grow at temperature lower than freezing point as low as -20^{o}C, which is lower than freezing point of water and thrive at temperature of 110^{o} C which is higher than the boiling point of water. Some bacteria grow unsurpassed under condition in more acidic than dilute hydrochloric acid. They cause wide range of diseases as food poisoning and typhoid fever. Ramachandran [2] found that bacteria are unicellular organisms which grow very rapidly under warmth and moistures environment. Bacteria grow from one organism to more than one billion in just 18 hours under ideal conditions. Some specific types of bacteria are pathogenic and cause cross infection. They are further divided into Gram positive (*Staphylococcus aurous*) and Gram -negative (*E-coli*). Various types of bacteria present on skins so when perspiration is produced it is directly infected with these bacteria. Due to bacteria reaction, perspiration odour and

deteriorating effect on fabrics were produced. Stout and Evelyn [4] found that micro-organisms create problem for textile raw materials and processing chemicals, wet processes in mills, transport and finished goods lying (in bulk) in storage and which are used by the consumers. It is a problem to athletes and consumers. Tortora and Phyllis [6] found that mildew, fungus or mould cause a whitish growth on fabric when stored in damp condition in a warm place. This growth damages the fabric and cause staining the fabric.

White and Monticello (2005)[7] found that the term antimicrobial means protection against micro-organisms. The antimicrobials are very different in their chemical nature, mode of action, impact on human beings and the environment. These antimicrobials are used on fabric to control bacteria, fungi, mould, mildew and algae. There are two types of micro-organisms good and bad. Jantas and Górna, [8] found that basically onto fibers or fabrics, antimicrobial properties is obtained by applying antimicrobial agents chemically or physically.

Ramachandran [2] found that antimicrobial agents are drugs designed to kill, or prevent the growth of microorganisms (bacteria, fungi, and viruses). It must be ensured that these substances are not harmful for skin and the environment. Dimethlytetradecyl (3-(trimethoxysilyl) ammonium chloride DTAC as antimicrobial agent is safe to man and the environment [9]. Tortora [7] found that chemicals such as phenol, formaldehyde and pentachloralphenol are not harmful for the fabric. So these are used to inhibit the growth of micro-organisms.

Purwar and Joshi [10] found that it is a challenge to develop a unique fabric and fabric finishes. These finishes should be durable during the fabrics finishing process; constant in the presence of other chemicals; wash-fast and evenly and consistently applied. It should be financially feasible and environmentally friendly. Bonin (2008)[1] investigated that antimicrobial finished fabric is easily finding a place in the global textile market. The end use of antimicrobial finish fulfills the need of many different people and their professions. The most of antimicrobial experiments are being performed for the medical industry on the other hand the apparel industry can definitely get benefit from this experiment. The reason is that product made for the two professions are closely related. So the use of safe and durable antimicrobial finish is steadily increasing. All over the world the use of natural fibers is emphasized.

Now days, a wide variety of antimicrobial finish is applied to nonwoven textile, such as disposable protective textile used in hospitals. For applying antimicrobial finish, the fiber contents of fabric are very important. Most synthetic fabric are hydrophobic, so they are not appropriate for some end use as compare to natural fiber. The natural fibers are bio-based so the use of natural fibers encouraged for end use product. Cotton is abundant in Pakistan and its mechanical properties are suitable for garments production. The cotton fabric is easy to care for and take well to bleaching when dealing with antimicrobial finishes. It is important to know how fiber reacts with bleaching. The chlorine and oxygen bleach are suitable for antimicrobial finish fabric.

This research will povide helpful information on antimicrobial cotton fabrics that will be beneficial to the medical industry and also for the general public. The new focus developed for antimicrobially finished textiles to protect the wearer from bactertia than it was to simply protect the garment from fiber degradation.

The main objective of this study was to find out the effects of antimicrobial finish on the abrasion resistance, crease recovery, tensile strength and wrinkle recovery of cotton fabric. In order to achieve this objective, following three research questions were developed.

1. What is the effect of antimicrobial finish on the abrasion resistance of cotton fabric?
2. Does antimicrobial finish have significant effect on the crease recovery of cotton fabric?
3. What is the effect of antimicrobial finish on the tensile strength of cotton fabric?
4. Does antimicrobial finish has significant effect on the wrinkle recovery of cotton fabric?

METHOD AND PROCEDURE

True Experimental design (Pre-test, Post-test) was used for the study. Literature emphasized this design for understanding such studies [11]. To compare the effect of the antimicrobial finish on cotton fabric first properties of untreated samples were tested then antimicrobial finish was applied then again same properties were checked to see that properties after finish remain the same, increase or deteriorate. All tests results were compared and according to effect of properties on cotton fabric can be used in different fields purposely.

The test was carried out in two steps. First the fabric properties were checked in Nishat Textile Limited. In the second step antimicrobial finish was applied in CEMB. Samples of the sheeting were cut, treated and tested to determine their efficacy as antimicrobial textiles. Cotton fabric consists of warp: ends/inch = 86, weft: picks/inch = 56 and weight is 65g/m2. It was plane weave. The cotton sheeting was cut into two equal halves, one for pretest and other for posttest. The untreated cotton sheeting was labeled "A" while treated cotton sheeting was labeled "B".

In pretest untreated "Sample A "of tested material was tested for the abrasion resistance, crease recovery, tensile strength and wrinkle recovery. The result was recorded as pretest. These tests were performed in Nishat Textile Limited Lahore and Centre of Excellence in Molecular Biology Lahore (CEMB) University of Punjab Lahore.

Microorganisms' presences were checked and antimicrobial finish was applied in a controlled lab environment at Centre of Excellence in Molecular Biology Lahore (CEMB) University of Punjab Lahore.

Application of antimicrobial finish

LB (Lauria Betini) agar was prepared for the experiment. Citric acid and methanol.

Aloe gel-Antimicrobial agent (5 gram per liter), extracted from *Aloe vera* leaves.

500 gram of grinded *aloe vera* leaves were taken into a jacketed extractor and subjected to steam exclusion which helped in removal of volatile impurities such as pesticides. The desired solvent was added in the ratio of 1:4 to 1:6 of *Aloe Vera* solvent. Extraction was done for 2-4 hours at temperatures of 40-45º C. The mixture was constantly stirred and samples of decoction were taken out at regular intervals to check the concentration of the active material in the extract. When the concentration level became almost

constant, the mixture was drained and filtered by using a centrifuge. The methonolic crude extract was treated with 1% aqueous hydrochloric acid (HCl) for 30 minutes after removal of neutral impurities with methanol which makes the extract in aqueous form. The extract was washed with water at 90ºC which removed the residual trace of methanol present in the extract. The filtrate (extract) was then transferred to a storage vessel [12]. The fabrics were immersed in the 5 gram per liter concentration of methanol extracted Aloe gel for five minutes and padded on adding mash individually in the presence of citric acid to maintain 5.5 pH. To get a wet pick up of 80% on weight of the fabric. The fabric was then dried at 80ºC for three minutes and cured at 110ºC for two minutes on a lab model curing chamber. Antimicrobial activity was determined by using Agar Plate method.

Tenfold Dilution preparation

The researchers took 4 culture tubes and filled it with 9 ml L.B Broth and label it. Then took 1ml from the *E.coli* culture containing treated fabric, mixed it and transferred 1 ml from previous of culture tube into next culture tube. Same procedure was repeated for making 10 fold Dilution for untreated fabric. After that 100 units from each culture were taken in tube and spread on it on the L.B Ager plates and noted resulted next day.

RESULTS: - A= Fabric untreated with *Aloe vera*
B= Fabric treated with *Aloe vera*

Table 1:
Fabric untreated with *Aloe vera*

Observations	A1	A2	A3	A4
1	50	52	45	40
2	42	45	35	39
3	40	30	40	35
Average	44	42.3	40	38
Average x Distribution Factor	4400	4230	4000	3800

Table 2:
Fabric treated with a*loe vera*

Observations	B1	B2	B3	B4
1	18	17	15	10
2	20	20	12	12
3	18	18	13	8
Average	16	15.6	13.3	10
Average x Distribution Factor	1600	1566	1330	1000

Figure 1: Martindale abrasion tester machine

In posttest the treated sample labeled as “Sample B” of tested material was tested for the abrasion resistance, crease recovery, tensile strength and wrinkle recovery. The results were recorded as Post Test. These tests were performed in Nishat Textile and CEMB Lahore

Abrasion resistance test

The Martindale abrasion tester machine was used. The test specimens rubbed under a known load against a reference fabric. The rubbing motion was in the form of geometric figure. The machine must be fitted with a presetting stops witch. The total load to be applied to each specimen must be (595±7g) for fabrics. When the selected number of rubs

Figure 2: Crease Recovery tester

reached, samples examined and assessed the intervals required for subsequent stops. As when end point was approaching the intervals between examinations decreased. Any pills that formed on the test specimens cut off with sharp scissors [13]. End point was reached when two or more threads were completely broken down. *P*hysical break down of a specimen was examined.

Crease recovery test

This test carried out with the help of Shirley crease recovery tester. For the Shirley crease recovery test specimens cut with a template of 2 inches long and 1 inch wide. A random sample was taken. Each specimen was carefully creased by folding into half and pressing it by placing between two smooth glass plates. 2 kg weight was applied. After one minute weight was removed. The specimen was taken out and transferred to the fabric clamp on the instrument and would allowed to recover from the crease. As it recovered, the dial of the instrument rotated to keep the free edge of the specimen in line with the knife. After one minute the recovery angle noted in degrees on the engraved scale. Warp and weft way recovery angle was noted separately. Three readings were taken in a similar way on each test sample and mean was worked out [13].

Tensile strength test

Samples were cut in both the warp and weft directions. 4" X 8-10" specimen. tensile testing machine.

Prepared the machine testing machine for the break to occur between 10-90% of full scale force. Set the testing machine for a loading rate of 12 in/minute. Mounted the specimen in the clamps as straight as possible so that the same length wise yarns were gripped by both clamps. If specimen clips in the jaws, or broke at the edge or in the jaws or performs

Figure3: Tensile tester

markedly below the average for the set of specimens, discard the result and take another specimen. Maximum force obtainable in the range used for the test. Note the average time required to break for acceptable specimens.

Wrinkle recovery test

Wrinkle Recovery of fabric AATCC-128-1999 method was used. A test specimen was wrinkled under standard atmospheric conditions in a standard wrinkling device under a predetermined load for a prescribed period of time. The specimen was then reconditioned in the standard atmosphere for textile testing and evaluated for appearance by comparison with 3-dimensional reference standards. Wrinkle recovery, that property of a fabric which enables it to recover from folding deformations.

DISCUSSION OF RESULTS

Abrasion Resistance

Table 3:
Comparison of abrasion resistance on treated and untreated samples

Fabric sample	ISO-12947	
Untreated fabric	@10000 Cycles	No Thread Breakage
Treated fabric	@10000 Cycles	No Thread Breakage

In both samples no breakage of thread was seen at 10,000 rubs per cycle, so antimicrobial finish did not affect the abrasion resistance of cotton fabric. Perhaps the reason was that the antimicrobial finish did not affect chemically on the structure of cellulose, so strength of cotton fabric does not affect. As a result antimicrobial finish did not affect the abrasion resistance. Bonin [1] supported this study as the antimicrobial treatment was not negatively affect the abrasion resistance of cotton fabric.

Crease recovery

The result showed that treated fabric showed more recovery angle 110^o as compared to untreated 90.3^o. As recovery angle increased or moved toward 180^o there became less fold. So after applying the finish crease recovery property slightly increase. The reason is that during the process starch was removed which cause increase the recovery angle.

As the data is dependent so paired t-test was applied which showed that t=-8.171 for treated and untreated fabric in As the data is dependent so paired t-test was applied which showed that t=-8.171 for treated and untreated fabric

Table 4:
Comparison of crease recovery on treated and untreated samples

Fabric sample	Recovery angle
Untreated fabric	90.1
	90.5
	90.3
Mean	90.3^o
Treated fabric	107
	115
	108
Mean	110^o

increase recovery. P value was .015 indicated significance results. Bonin [1] study result was opposite/contradicts this study as the application of antimicrobial finish degrades the crease recovery of treated fabric.

Tensile strength

Table 5:
Comparison of tensile strength on treated and untreated samples

Sr#	Fabric sample	Tensile Strength	Extension (%)	Time of break (seconds)
1	Untreated sample	239.04	9.55	3.1
2	(warp)	218.77	9.34	3.0
3		213.60	8.73	2.7
	Mean	223.80	9.21	2.9
1	Treated sample	198.77	12.03	3.8
2	(warp)	191.73	11.38	3.5
3		215.17	11.24	3.7
	Mean	201.89	11.55	3.7
1	Untreated sample	141.44	22.55	7.0
2	(weft)	140.61	21.21	6.3
3		140.09	25.62	7.8
	Mean	140.71	23.12	7
1	Treated sample	136.32	20.83	6.4
2	(weft)	117.93	19.69	6.3
3		118.66	19.58	6.3
	Mean	124.30	20.03	6.3

Mean values were calculated for both warp and weft direction of treated and untreated samples. The untreated warp showed good tensile strength as compared to treated fabric. Same results were found in case of weft direction. One reason of this difference was that when apply the finish some shrinkage was occurred, this shrinkage in sample cause reduction of strength. On the other hand the starch of treated sample was removed which also caused to reduce the strength. In warp there was more shrinkage as compared to weft.

As the data is dependent so paired t-test was applied which showed that in warp treated and untreated fabric t=1.775 and P value was .218 indicated the significance results, interpreting that after treatment warp in tensile strength was affected. Same in case of weft as t=2.901 and p value was .101 indicated the significance results, interpreting that after treatment weft in tensile strength was affected.

Bonin (2008)[1] supported this study to conducted a research on fabric properties by applying antimicrobial

finish. In that research chitosan and the chitosan/PEG was used as
antimicrobial agents, while *aloe vera* extract which was herbal used in this study. The use of chitosan and the chitosan/PEG in antimicrobial finish negatively affected the cotton textile as this agent degrades the tensile strength.

Wrinkle recovery

Table 6:
Comparison of wrinkle recovery on treated and untreated samples

Fabric sample	AATCC-128
Untreated fabric	1
Treated fabric	1

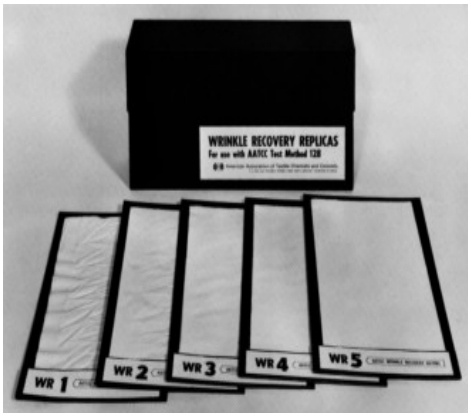

Figure 4: standards for wrinkle recovery

Both treated and untreated samples showed same rating that was 1, which mean anti-microbial finish did not affect the wrinkle recovery of cotton fabrics.

Conclusions and Recommendations

The test results revealed that antimicrobial finish positively affect the crease recovery while abrasion resistance and wrinkle recovery remain the same on both treated and untreated samples. On the other hand antimicrobial finish negatively affects the tensile strength. *Aloe vera* antimicrobial agent was used; it is an herbal agent so is not harmful for the wearer and also for the fabric.

The results showed that the fabric treated with solution of aloe gel showed 74% reduction in the presence of microorganism. The treated sample showed high reduction rate in the number of colonies grown.

In view of the findings and conclusions of the study, following recommendations are put forwarded for the future researchers and educators.

- Some of the fabric properties were negatively affected, may be it is due to the reason that starch was present in the fabric, so it is recommended that starch should be removed prior to conducting the pretest and also for experiment.
- As cotton mostly used with starch so starch was applied on both treated and untreated fabric after applying the finish.
- Suggestions for continued work include that laundry of treated fabric would check. In this case after applying antimicrobial finish, wash the fabric five times and then check the presence of microorganisms. Repeat this process more than fifty washes.
- The study was confined to only checked four properties and recommended to check other properties of fabric as much as possible.
- Weave, weight and quality of fabric was checked but blend was difficult to find so it is recommended that standard fabric should be taken from textile mill to check the ratio of blend and other properties alike.
- It is also recommended to study *S, aurious* and other microbes as algae, fungi and mold etc.
- For future research it was recommended that increase the concentration level from 6 gram per liter upto 10 gram per liter and then check the effect on fabric property.
- There is need to apply antimicrobial finish on other fabric as wool and synthetic fabric etc.

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