P-3441

ANTIMICROBIAL AND BLOOD REPELLENT FINISHES FOR SURGICAL FABRICS

PROJECT REPORT

Submitted by

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of

BACHELOR OF TECHNOLOGY

in

TEXTILE TECHNOLOGY

KUMARAGURU COLLEGE OF TECHNOLOGY

COIMBATORE – 641 049

(An Autonomous Institution Affiliated to Anna University of Technology: Coimbatore)

APRIL 2011

BONAFIDE CERTIFICATE

Certified that this project report **"ANTIMICROBIAL AND BLOOD REPELLENT FINISH FOR SURGICAL FABRICS"** is the bonafide works of **"M.HARIKRISHNAN, E.B.RAJGOWTHAM, S.SENTHILKUMARAN, S.V.ANATHNARAYANARAJA"** who carried out this project work under my supervision.

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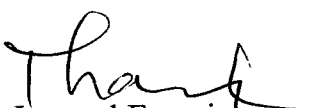
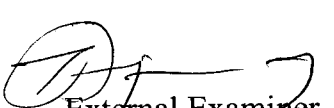


Internal Examiner



External Examiner

ACKNOWLEDGEMENT

We express our sincere gratitude to our beloved Co-Chairman, **Dr. B.K. Krishnaraj Vanavarayar, Dr. J. Shanmugam**, Director, Kumaraguru College of Technology and **Dr. S. Ramachandran**, Principal for their support and allowing to use the facilities of the institution.

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It gives us great pleasure to express our deep sense of gratitude for our supervisor, **Mr.P.Chandrasekaran**, Assistant Professor, Department of Textile Technology, Kumaraguru College of Technology, for his innovative guidance, expert suggestions and constant encouragement at every step for the study.

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Words fail to express thanks to our beloved family members and friends who are our sounding board and pillar of strength.

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ABSTRACT

Surgical fabrics are important components of surgical apparels and in hospitals. They are expected to perform as barriers and provide increased protection to the health care workers. These continues to be a growing demand from operation theatre staff for improved security and protection against blood and liquid borne pathogens, especially against viruses such as Hepatitis B.

On a global basis, single use non-woven products are now used in about 60– 70% of all surgical interventions. Several studies have confirmed the superiority of single use surgical products in terms of resistance to bacteria.

However, in India, majority of the hospitals use only woven products for surgical apparels (particularly surgical gowns). The woven gowns are washed and sterilized before use. In 90% of the hospitals, where woven products are used as surgical gowns, they are used without any functional finishes. The argument against finishing the surgical gowns is that finishing brings down the breathability of the surgical gowns and hence they are not comfortable to wear.

Recently, Nano finishes were introduced in the market and as per claims Nano finishes do not affect the breathability of treated fabrics. However, no published data is available in this aspect. The present study is proposed to generate relevant information in this area.

To investigate and identify appropriate nano finishes towards providing anti-bacterial and blood repellent characteristics to woven surgical gowns. To study the relative advantages of nano finishes (over conventional finishing chemicals) in terms of breathability (air permeability, water vapour transmission and wickability) of treated fabrics.

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LIST OF ABBREVATIONS

- gms – Grams
- mm – Millimeter
- mpm – meters per minute
- gpl – Grams per liter

INTRODUCTION

CHAPTER 1

INTRODUCTION

Textile products can provide all such requirements for bacterial growth, which result in the range of undesirable side effects. The presence of microorganisms can cause health problems, odour and finally fabric detoriation.

As microbes often attack the additives applied to the textile, discoloration and the loss of its functional properties such as elasticity (brittleness) are tensile strength can also occur.

Among the side effects for the fabric there also exists the side effect for the human in contact with the textile which is with the presence of microorganism. Antimicrobial and blood repellant finish has been applied to cotton fabrics used for surgical gowns, bed linens and drapes to reduce the surgical site infections. The extract of neem was applied to the fabric for imparting antimicrobial activity by pad-dry-cure method. The neem treated fabric was then imparted blood repellency through two different techniques, namely by treatment.

Plasma treatments have their numerous advantages over conventional wet processing techniques. In this study, the woven fabric, commonly used for surgical gowns, is treated with antimicrobial finishes and plasma containing fluorocarbon gas. Treated samples are evaluated for changes in physical and functional characteristics. The plasma treatment does not alter the weight, thickness, stiffness, air permeability, and breaking strength and elongation. Plasma-treated and water-repellent Sontara samples show higher blood and water resistance compared to other treatments. Plasma-treated samples also show a zone of inhibition for *Staphylococcus aureus*, thus providing a barrier against microbes. There is no zone of inhibition for the water repellent Sontara, untreated and wet control samples. This implies that the woven fabric treated with plasma can provide a better barrier against microbes than commonly available surgical gown fabric with a fluorocarbon finish.

1.1 SCOPE OF THE PROJECT

- The surgical fabrics are highly subjected to human blood.
- Blood is the main source for cross-infection.
- Even body fluids are carriers of microorganisms transferred through the barrier materials like surgical fabrics.
- Hence textile material with resistance to such microorganism and infection is to be produced to keep the hospital personnel and patients safe.

1.2 OBJECTIVES

- To apply with Anti microbial for the bleached woven fabric using Neem extract and Zycrobial.
- Apply blood repellent finish to the anti microbially treated fabric using Superfex.
- Test the fabric for the efficacy of anti microbial and repellency.

1.3 PRINCIPLE OF ANTIMCROBIAL ACTIVITY

Controlled release (e.g. micro encapsulation), durable and regenarable principle, and blocking action are the three currently used techniques.

The majority of antibacterial finishes function by the controlled release mechanism. It is based on the principle of applying the chemical finish to that would produce an active germicidal species continually regenerated by, say the addition of a bleaching agent during laundering, or the exposure to uv light, which would break some strategic co-valent bond in the chemically modified fibre during re-generation thus the model has theoretically an unlimited reservoir of antibacterial agent. The micro encapsulation technique comes closes to the model, though its reservoir antibacterial compound is not unlimited.

Micro encapsulation, although not the chemical finishing process, is a physicochemical where the antimicrobial compound is heald in a micro or nana capsule. As the capsules burst under agnation or mechanical pressure, they release the active compound. Encapsulation technology is

proven to be the best for achieving good antimicrobial durability for synthetic fibers. Substrates like polyester cellulosic vinyl acetate and polyethylene can also be treated. Mattress covers for e.g. can be protected against mites and other microbes for over 6 year this way. However this kind of technology does not work well on cotton due to the properties of fibre. For treating cotton the microcapsules themselves are modified with the multifunctional reactive groups that are capable of forming covalent bond with the fibre. One such system comprises a combination of carboxyl methyl starch (CMS), trimethylolated melamine (TMM) and cu+ ions in presence of an acid catalyst.

LITERATURE REVIEW

CHAPTER 2

LITERATURE REVIEW

➢ According to Seungsin Lee:

In order to impart barrier properties against microorganisms and blood to 100% cotton fabrics and 55/45% wood pulp/polyester spun laced nonwoven fabrics, samples are treated with chitosan and fluoropolymers using the pad-dry-cure and pad-cure methods, respectively. Antimicrobial activity of the samples is analyzed quantitatively by measuring the number of colonies of *Staphylococcus aureus*. Blood repellency is assessed with an impact penetration test using synthetic blood. Laundering durability of the finishes is measured, and scanning electron microscopy is used to evaluate changes in the fabric surfaces. To investigate the effect of finishing on the hand and air permeability of fabrics, the mechanical properties of the samples are measured by the KES-FB system. Samples treated only with chitosan show a high reduction rate in the number of colonies. Dual finished specimens treated with 1.1 % chitosan concentration also maintain over 90% reductions in the number of colonies. The blood repellency of dual finished nonwoven fabrics is superior to that of dual finished cotton. Dual finished cotton fabrics exhibited durable antimicrobial activity with repeated laundering. As regards mechanical properties, bending rigidity and shear rigidity increase when cotton and nonwoven fabrics are treated only with chitosan, but these properties decrease after the fluoropolymer treatment. Air permeability of the specimens decreases slightly after the dual finish.

➢ According to Thilagavathi, G and Kannaian, T:

Antimicrobial and blood repellant finish has been applied to cotton fabrics used for surgical gowns, bed linens and drapes to reduce the surgical site infections. The extract of neem was applied to the fabric for imparting antimicrobial activity by pad-dry-cure method. The neem treated fabric was then imparted blood repellency through two different techniques, namely by treatment with fluoropolymer (3%, 4% and 5% owf) using pad-dry-cure method and by 'sputter deposition of Teflon' technique using argon plasma. The antimicrobial activity is found to be

higher for Teflon deposited fabric than for the fluoropolymer finished fabric. Blood repellency increases with the higher concentration of fluoropolymer and the highest repellency for the Teflon deposited fabric is observed at 80W power and 20 min exposure in the plasma chamber.

- According to Rajpreet:

Plasma treatments are gaining popularity in the textile industry due to their numerous advantages over conventional wet processing techniques. In this study, the nonwoven fabric Sontara®, commonly used for surgical gowns, is treated with antimicrobial finishes and plasma containing fluorocarbon gas. Treated samples are evaluated for changes in physical and functional characteristics. The plasma treatment does not alter the weight, thickness, stiffness, air permeability, and breaking strength and elongation. Plasma-treated and water-repellent Sontara samples show higher blood and water resistance compared to other treatments. Plasma-treated samples also show a zone of inhibition for *Staphylococcus aureus*, thus providing a barrier against microbes. There is no zone of inhibition for the water repellent Sontara, untreated and wet control samples. This implies that the nonwoven fabric treated with plasma can provide a better barrier against microbes than commonly available surgical gown fabric with a fluorocarbon finish.

- According to Rajkumar:

Microbial infestation poses danger to both living and non-living matters. Obvious smell from the inner garments such as socks, spread of diseases, staining and degradation of textiles are some of the detrimental effects of bad microbes. Though the use of antimicrobials have been known for the decades, it is only in the recent couple of years several attempts have been made on finishing textiles with antimicrobial compounds. The consumers are now increasingly aware of the hygienic life style and there is a necessity and expectation for a wide range of textile products finished with antimicrobial properties. The present work aims at developing an eco friendly natural antimicrobial finish from aloe Vera plant for textile application. The aloe jell, commercial jell and leaf extract are applied on cotton fabric in pad dry cure method. An extensive study was conducted to assess the antimicrobial effectiveness of the herbs by employing standard test methods and the findings are discussed in this paper.

- According to Gulay Oscan:

In a study, plain woven fabrics were chose to investigate the effects of repellent finishes on woven fabric properties. The fabrics were treated with different types of water repellents at different concentrations. The levels of water repellency of the fabrics were measured in accordance with the AATCC 22 (1996) spray test method. To evaluate the effect of water repellent finishes on the woven fabric properties, breaking strength, abrasion resistance, pilling, light fastness, washing and perspiration tests of the fabrics were performed using relevant British Standards, ASTM and ISO standards. Wetting time of the fabrics was also measured before and after abrasion, washing and perspiration tests to evaluate performance and durability of the treatments. The results, evaluated using SPSS statistical program, showed that the water repellent finish type and concentrations were very important parameters to obtain water repellent fabric having acceptable use properties.

- According to young ho kim 1 *, chang woo nam 2, jae won choi 1, jinho jang

N-(2-hydroxy) propyl-3-trimethylammonium chitosan chloride (HTCC), a water-soluble chitosan quaternary ammonium derivative, was used as an antimicrobial agent for cotton fabrics. HTCC has a lower minimum inhibition concentration (MIC) against Staphylococcus aureus, Klebsiella pneumoniae, and Escherichia coli compared to that of chitosan; however, the imparted antimicrobial activity is lost on laundering. The wrinkle recovery angle and strength retention of the treated fabrics were not adversely affected with the addition of HTCC. Therefore, BTCA can be used with HTCC in one bath to impart durability of antimicrobial activity along with durable press properties to cotton fabric (1).

- According to Yuan Gao and Robin Cranston in Recent Advances in Antimicrobial Treatments of Textiles

The growth of microbes on textiles during use and storage negatively affects the wearer as well as the textile itself. The detrimental effects can be controlled by durable antimicrobial finishing of the textile using broad-spectrum biocides or by incorporating the biocide into synthetic fibers during extrusion. Consumers' attitude towards hygiene and active lifestyle has created a rapidly

increasing market for antimicrobial textiles, which in turn has stimulated intensive research and development. This article reviews the requirements for antimicrobial finishing, qualitative and quantitative evaluations of antimicrobial efficacy, the application methods of antimicrobial agents and some of the most recent developments in antimicrobial treatments of textiles using various active agents such as silver, quaternary ammonium salts, polyhexamethylene biguanide, triclosan, chitosan, dyes and regenerable N-halamine compounds and peroxyacids. Examples of commercial antimicrobial products are presented to illustrate the active agents used and their finishing methods (2).

- According to Arvye Davis, Principal Investigator: Randall Sumner in the Evaluation of a Silane Quaternary Ammonium Salt as an Antimicrobial Fabric Treatment

Antimicrobial agents are used to kill or limit growth of microorganisms. ÆGIS Microbe Shield™, an antimicrobial agent composed of a silane quaternary ammonium salt, is featured for its durability and efficacy against both gram-negative and gram-positive bacteria. This research studied the effectiveness of the antimicrobial agent as a treatment for cotton fabric. Cotton fabric samples were coated with the antimicrobial agent, and then tested against three species of bacteria. The samples were shaken in a bacterial solution to allow contact with the microbes, and the number of viable bacteria was counted. The data were compared to the numbers of bacteria with untreated fabric. This research reveals that the antimicrobial agent reduced the numbers of bacteria exposed to the treated cotton fabric (3).

- According to : Deepti Gupta and Komal Saini in Low molecular weight chitosan derivatives for antimicrobial treatment of cotton

Cotton fabric was first dyed and then treated with chitosan to see if the treatment would have any effect on the color. Results for two reactive dyes are compiled. It can be seen that treatment with chitosan or its LMW derivative does not affect the color or the wash fastness in any way. It can be hence be said that chitosan treatment, whether given before or after dyeing, does not affect the color or fastness of reactive dyes in any way (4).

- According to W. Curtis White Robert A. Monticello Ph.D., James W. Krueger in a comparison of antimicrobials for the textile industry

The term antimicrobial refers to a broad range of technologies that can provide varying degrees of protection for textile products against microorganisms. Antimicrobials are very different in their chemical nature, mode of action, impact on people and the environment, in-plant-handling characteristics, durability on various substrates, costs, and how they interact with good and bad microorganisms (5).

- According to MP. Sathyanarayanan, M. Bhat, S. Kokate, Bombay textile research assn.,

An ecofriendly natural antibacterial finish has been prepared from the plant extracts for textile application. Herbal extracts from *Ocimum sanctum* (tulsi leaf) and rind of *Punica granatum* (pomegranate) have been applied to cotton fabric by the method of direct application, micro-encapsulation, resin cross-linking and their combinations. All the treatments show good antibacterial properties for the fabrics. Except the method of direct application, all other treatments show good washing durability up to 15 washes. The surface morphological studies using SEM show the surface coating, microcapsules and some fibrillation. The GC-MS studies reveal that the major components responsible for the antibacterial properties are Eugenol, Germacrene and Phytol. A small decrease in tensile strength and crease recovery angle is observed for resin treated and micro-encapsulated fabrics respectively. But in the combined processes no significant changes are observed.

- According to Dr.T Ramachandran, Member K Rajendrakumar, Non-member R Rajendran, Non-member in Antimicrobial Textiles — an Overview

Microbial infestation poses danger to both living and non living matters. Obnoxious smell form the inner garments such as socks, spread of diseases, staining and degradation of textiles are some of the detrimental effects of bad microbes. The consumers are now increasingly aware of the hygienic life style and there is a necessity and expectation for a wide range of textile products finished with antimicrobial properties. The new developments such as non-leaching type of finishes would help reduce the ill effects and possibly could comply with the statutory requirements imposed by regulating agencies (6).

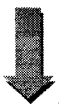
MATERIALS AND METHODOLOGY

CHAPTER 3

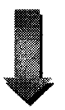
MATERIALS AND METHODS

3.1 PROCESSING SEQUENCE

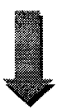
Cotton fabric



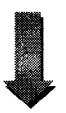
Bleaching the fabric (using Hydrogen peroxide)



Treating the fabric with antimicrobial finish (using Zycrobial)



Treating the fabric with Blood repellent finish (using Superfex fluoro carbon compound)



Testing

3.2 MATERIALS

Fabric:

The fabric was sourced from Sri Chakra Exports, Karur and was bleached. In each loom cycle the tip of the single rapier is inserted across the whole width of the shed and then withdrawn. The main advantage of this system is that the problems of weft transfer do not arise and normal range of fabrics can be woven. Weft insertion rate followed is 400 mpm.

Loom Width	2 meters
Warp Count	40 Ne
Weft Count	40 Ne
Ends Per inch	82
Picks per inch	64
GSM	108

Bleaching:

The temperature for bleaching is 85°c and pH of 0-5. The solution is made alkaline with NaOH. Sodium silicate is mostly used as a stabilizer. After bleaching the material is washed with cold water and dried.

Recipe:

Hydrogen peroxide – 0.5 -2 vol

Sodium silicate – 2 gms/ lit

Temperature: 80-85°c

M: L: 1:20

Anti Microbial finish:

The chemical was sourced from Zydex Industries, Vadodara. The finish was given to the fabric by the pad, dry and cure method. This finish was given at Roopa finishers, Tirupur. Broad spectrum antimicrobial and antimite activities have been introduced in copper impregnated fibers and polyester products for production of antiviral gloves and filters (which deactivate HIV-1 and other viruses). Antimicrobial self-sterilizing fabrics (which kill antimiotic-resistant bacteria), antifungal socks (which alleviate symptoms of athlete's foot),and antidust mite mattress covers. Copper compounds are extensively used for the preservation of tents, canvas, bags and geo textiles. A familiar compound copper naphthanate is available under trade names, such as Cuprimol and Nuodex. Mixtures of copper and zinc naphthanate with mercuric or phenylmercuric naphthanate are even better. Treatment of cellulosic fabrics with succinic anhydride followed by metallic salts such as copper sulfate and zinc sulfate also imparts activity durable up to 10 laundering cycles.

Copper-carboxymethyl starch and trimethylolated melamine with cotton fabric also give excellent antimicrobial properties. Each fabric sample washed with acetone for three hours at room temperature and rinsed with distilled water. Fabric samples were pretreated with succinic Anhydride in a solvent mixture of dimethyl sulfoxide (DMSO)and N,N-DimethylBenzylamide(DMBA)for fifteen hours at 20°C. The composition of the solvent was 20:0.3. The liquor ratio was 1:20. After the reaction samples were washed with 50 ml of acetone three times, rinsed with distilled water and then dried. The pretreated fabric were then treated with 0.5M metallic salt solution dissolved in 0.5M acetate buffer solution with a ph of 4.6 at room temperature and at a liquor ratio for 1:50 for 24 hours under intermittent stirring. The treated fabrics were rinsed with distilled water five minutes and dried.

Blood repellent finish:

The chemical was sourced from Avanza chemicals international, Hyderabad. This finish was given at Roopa finishers, Tirupur.

Recipe:

Superfex 555: 60 gpl

(Fluoro carbon compound)

Superfex 655: 20 gpl

(FC extender)

Acetic Acid : 0.5 gpl

The process is carried out with the padding of 80% of the recipe and then followed by drying at 145°C. This is then followed by curing at 160°C to 170°C for 2 to 3 minutes.

3.3 TESTING METHODOLOGY:

Swatches of test and control textile materials are tested qualitatively for antibacterial activity by AATCC method 147,100 and AATCC method 42 for blood repellent effectiveness. Those showing activity are evaluated quantitatively. Test and control swatches are inoculated with the test organisms. After incubation, the bacteria are eluted from the swatches by shaking in known amount of neutralizing solution. The number of bacteria present in this liquid is determined, and the present reduction by the treated specimen is calculated.

Test of bacteria:

Staphylococcus aureus, American Type Culture Collection No:6538. Gram positive organism.

Klebisiella pneumonia, American Type Culture Collection No:4352.Gram negative organism.

Culture Medium:

Peptone (bacto-peptone)	5g
Beef extract	3g
Distilled water	1000 ml

Heat the above solution to a boil to disperse ingredients. Adjust to pH 6.8±0.1 with 1N sodium hydroxide (NaOH) solution. (This is not necessary if prepared, dehydrated medium is used). Dispense in 10 ml amounts in conventional bacteriological culture tubes (i.e.125×17mm). plug and sterilize at 103kPa(15 psi) for 15 min.

Test of blood penetration:

Blood repellency is assessed with an impact penetration test using synthetic blood. Laundering durability of the finishes is measured, and scanning electron microscopy is used to evaluate changes in the fabric surfaces. To investigate the effect of finishing on the hand and air permeability of fabrics, the mechanical properties of the samples are measured by the KES-FB system. Samples treated only with chitosan show a high reduction rate in the number of colonies. Dual finished specimens treated with 1.1 % chitosan concentration also maintain over 90% reductions in the number of colonies. The blood repellency of dual finished nonwoven fabrics is superior to that of dual finished cotton. Dual finished cotton fabrics exhibited durable antimicrobial activity with repeated laundering. As regards mechanical properties, bending rigidity and shear rigidity increase when cotton and nonwoven fabrics are treated only with chitosan, but these properties decrease after the fluoropolymer treatment. Air permeability of the specimens decreases slightly after the dual finish.

RESULTS AND DISCUSSION

CHAPTER 4

RESULTS AND DISCUSSION

4.1 Effect of antimicrobial activity:

Sample No.	Sample Particulars	Bacterial Reduction (in %)		
		Staphylococcus aureus (ATCC 6538)	Klebsiella Pneumoniae (ATCC 4352)	Remarks
1	Cotton fabric (Untreated)	1	1	No Antimicrobial activity
2	Cotton fabric (treated)	68	69	Excellent Antimicrobial activity

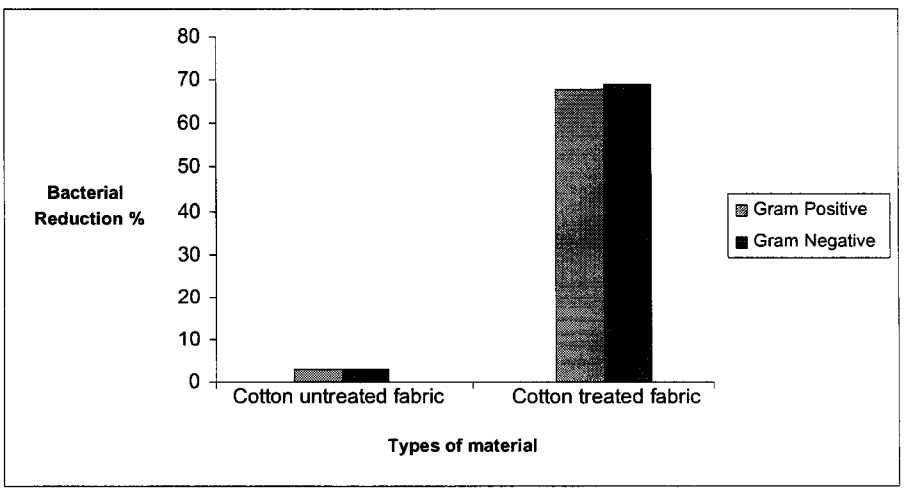


Fig 4.1 Antimicrobial activity

4.2 Effect of Blood repellent finish by impact penetration:

S.no	Sample	Blood penetration (g) (AATCC 42)	Fluoro carbon ratio percentage taken	Repellency remarks
1	Cotton fabric (Untreated) 0%	23.68	0	No Repellency
2	Cotton fabric (treated) 3%	11	50	Minimal
3	Cotton fabric(treated) 4%	17	70	Minimal
4	Cotton fabric (treated) 5%	2	80	Excellent

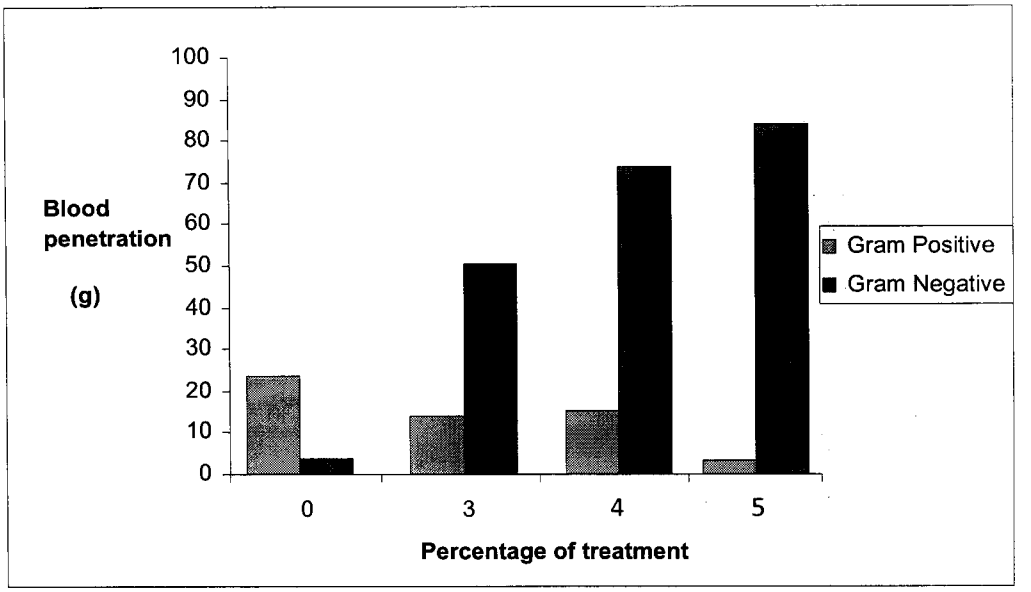


Fig 4.2 Effect of blood repellency

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XXIV/21658/2011 26.03.2011

Mr. E.B.Raj Gowtham

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Ch.T.R.No.2885

Dear Sir,

This is with reference to your letter No. KCT/TXT/STUPRJ/2011(PC)/2 dt. 17.02.2011 regarding the two samples sent to us for testing the Antimicrobial activity and Blood repellent impact penetration test.

(i) Assessment of Antimicrobial Activity by Bacterial Reduction Test (AATCC TM 100-2004)

Sample No.	Sample Particulars	Bacterial Reduction (in %)		
		Staphylococcus aureus (ATCC 6538)	Klebsiella Pneumoniae (ATCC 4352)	Remarks
1	Cotton fabric (Untreated)	1	1	No Antimicrobial activity
2	Cotton fabric (treated)	68	69	Excellent Antimicrobial activity

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(ii) Assessment of Blood Repellency by Impact Penetration Test (AATCC TM 42-2000)

S.no	Sample	Blood penetration (g) (AATCC 42)	Fluoro carbon ratio percentage taken	Repellency remarks
1	Cotton fabric (Untreated) 0%	23.68	0	No Repellency
2	Cotton fabric (treated) 3%	11	50	Minimal
3	Cotton fabric(treated) 4%	17	70	Minimal
4	Cotton fabric (treated) 5%	2	80	Excellent

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Inoculum size: S.aureus : $1.5*10^8$ cfu/ml, K.Pneumoniae : $1.5* 10^8$ cfu/ml

The culture flask was incubated for 18 hours followed by enumeration.

The reduction percentage was calculated by taking control (without samples) into consideration

Yours faithfully,

Incharge –Testing(Textile Chemistry)

Encl : Bill

CONCLUSION

CHAPTER 5

CONCLUSION

- The increased blood repellency is due to the cross linking between the carbonyl groups (-C=O) created by the hydroxyl groups of the cotton and C-F fragments of the fluorocarbon.
- The literature containing the FT-IR and XRD analysis confirm with the above theory.
- The antimicrobial efficacy of the fluorocarbon treated fabric is stable and reduces at with the increase in the blood repellency.
- The antimicrobial and blood repellency of the sample are found to be best at the minimal percentage of both the finish compounds used.
- The deposition of the fluorocarbon on the fabric is very uniform and that is the probable reason for effectiveness. The pore size becomes more closed and also with less number of protruding fibers.

REFERENCES

CHAPTER 6

REFERENCES

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